HANDBOOK

OF THE

PRACTICE AND ART OF PHOTOGRAPHY,

BY

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REVISED AND CORRECTED BY THE AUTHOR, AND ESPECIALLY ADAPTED FOR THE UNITED STATES.

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PREFACE

TO THE GERMAN EDITION.

THREE years have elapsed since the first part of the work which has now reached its conclusion appeared before the public.

Many things combined to retard its completion. Particularly the void which I found in our knowledge of Photo-Chemistry, Photographic Optics, Practice, and Æsthetics. These very circumstances cause in me the desire to attempt, so far as is in my power, to remedy this defect.

I laid aside my pen, after a few sheets had been written, in order to carry on, for several months, experiments in chemistry and optics, and investigations of a technical and æsthetic character. I had to create first the material for many chapters of this book before I could write them. I need only refer to my works on *Sensitizers*, on the *Photo-Chemistry of Chlorine*, *Bromine*, and *Iodide of Silver*, on *their Changes in the Bath*, on *Silver Trituration*, on *Collodion*, on *Microphotography*, on *Testing Object Glasses*, on the *Carbon Printing Process*, on *Photometry*, on the *Principles of Illumination*, on the *Construction of the Atelier*, and on *Perspective in Portrait Photography*, not to mention many smaller publications; and this must be my excuse for requiring so much time in laying my book before the public.

On the other hand, I was frequently interrupted in my labors. The International Exhibition of 1867 called me to Paris; the expedition to observe the solar eclipse of 1868 called me to Aden, in Arabia; the Photographic Archæological Expedition of the same year required my presence in Upper Egypt. The manuscript of

my book was my companion. Some chapters were written in Paris, others on the Red Sea; some on the Nile, and before the last sheet leaves the press, I follow the kind invitation of the American photographers and cross the Atlantic. The correction of the proof I had to leave to others. Many errors in printing and in the arrangement remained necessarily under these circumstances uncorrected. I crave for them the leniency of the public.

Want of space prevented the discussion of the Photolithographic and Woodbury Processes, as well as Positive and Negative Retouch. For the study of the latter, I recommend the excellent little work on Retouching, by Grasshoff.

For the third part, The Photographic Æsthetics, I implore the mild judgment of the professional artist. It is not my purpose to enter into discussions whether photography is an art or not. I start from the fact established by experience, that a sharp and faultless portrait or landscape picture does not satisfy us, when the laws of art, the observance of which is the cause of our pleasure in the works of the drawing artist, have been neglected.

So far as these laws are applicable to photography, I have endeavored to illustrate them by examples. In this branch the production of proper illustrations offers great difficulties. Only a few could be taken from the articles of Robinson, published in the "Mittheilungen." For the majority I am indebted to the art establishment of A. Seemann, in Leipzig.

DR. H. VOGEL.

BERLIN, April 15, 1870.

PREFACE

TO THE AMERICAN EDITION.

I HAVE endeavored to lay down in this book not only the formulæ, a description of the different apparatus and manipulations which are necessary for the mechanical production of a photographic picture, but I have tried also to elucidate those art principles which we must follow when we wish to make an artistically beautiful picture.

Unless we treat the pose and illumination in an artistic manner, the best of chemicals and the most exquisite lenses will fail to produce a beautiful picture. To speak of these principles is for a Photographic Handbook a necessity, particularly as at present portraiture is the most important branch of photography, and is likely to remain so.

The description of positive and negative retouching I omit, as they have been treated in so excellent a manner by Mr. Ayres.*

In the American edition I have tried to adapt the Handbook to the wants of the American photographic public, and prize it indeed as a great favor that, thanks to the honorable invitation which I received to visit this country, I was enabled to inspect personally the American photographic establishments, and to appreciate them.

I shall feel happy if my work should receive as many friends as I had the good fortune to meet during my brief stay in the United States.

DR. H. VOGEL.

PHILADELPHIA, August 12, 1870.

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* How to Paint Photographs.

INTRODUCTION.

A careful study of the history of invention will show but few periods as rich in new ideas and facts as the past hundred years.

With the rise of the explaining natural sciences—chemistry and natural philosophy—commenced a new era by applying the discoveries to actual life and industrial pursuits. Thus originated the *steam engine*, *gas*, *sulphuric acid*, the manufacture of *soda*, *beet-root sugar*, the manufacture of *ultramarine*, not to mention numerous other things in which the physical or chemical action of heat was used in a new form.

In an analogous manner we see another of the natural forces, formerly unused, enter as an active agent into our industry,—*electricity*. Weber created the *electro-magnetic telegraph;* Jacoby the *galvanoplastic* process.

Finally, the present age brought forth an art in which the *chemical action of light* is the principal agent. *This art is Photography.* It has existed only twenty-five years, and still we may say that no invention of this century has since its first appearance experienced such a gigantic development and exercised so powerful an influence on our social, artistic, and scientific relations as this one. At first a mere method of taking portraits, its application has now extended to almost all the branches of human knowledge and science. It supplies a natural self-print in the widest sense of the word,—it furnishes the naturalist with faithful representations of animals, plants, and minerals; the geographer obtains from it the basis from which to develop his maps; it makes for the engineer in a few moments faithful copies of the most complicated machinery, and reproductions of his drawings and plans, which would occupy

the time of the most skilful draughtsman for weeks; it supplies him with an authentic foundation for the construction of plans and maps; it is employed successfully in lithography, and porcelain painting; it serves the artist for multiplying his productions, and places copies of inimitable truthfulness at a moderate price within the reach of all; it is as important an auxiliary for developing a taste for art in the people as the invention of printing is for the dissemination of knowledge.

Let us briefly consider how this art developed itself. There are many inventions which originated by accident, by the favor of the moment; as instances, we may mention gunpowder, the deflection of the magnetic needle by the galvanic current, and the telescope; but others required years of thoughtful study and experiment before they could take their place amongst the inventions. Photography belongs to the latter class.

It was long known that chloride of silver would turn dark on being exposed to light. It was also known that paper, the skin, &c., when wetted with a solution of silver, would be discolored by the light of the sun. But only in the beginning of this century the idea was conceived to use these facts for the production of pictures by the agency of light.

Two Englishmen, Davy and Wedgewood, made the first experiments of the kind in the year 1802. They placed a piece of paper in a solution of silver, brought it into contact with an opaque object—for instance, a silhouette—and exposed it to sunlight. All that part of the paper not covered by the silhouette turned brown by the action of light; the balance of the paper remained white; thus a white picture on a brown ground was produced. *This was the first light picture.*

Unfortunately these pictures were not permanent. The part which remained white soon darkened by the action of diffused light, and finally the picture disappeared by the influence of the same agency to which it owed its origin.

Davy photographed in this manner the image of the solar microscope.

Almost simultaneously with Davy and Wedgewood, a French-

man, by the name of Niepce, entertained the idea of making pictures by the agency of light.

From the year 1814 he worked incessantly; he experimented for years, but approached only step by step to the desired end,—the production of *permanent* pictures by the agency of light.

While by the method of Wedgewood and Davy only flat objects, which could be placed in close contact with the sensitive paper, such as leaves, drawings, &c., permitted of being copied by the process, M. Niepce aimed to obtain representations of all kinds of objects in nature,—portraits, landscapes, &c. By the aid of the camera obscura, which the physicist Porta invented in the sixteenth century, he succeeded in this.

Wedgewood had already the idea to fix the charming pictures of this instrument on his paper, but it was not sensitive enough. Niepce resorted to another preparation sensitive to light,—namely, a solution of *asphaltum in oil of lavender.* With such a solution he coated a metal plate and exposed it for hours in the camera. The places which had been exposed to light became insoluble, and in the after-treatment with ethereal oils remained on the plate and formed a picture.

By this process Niepce produced imperfect light pictures as far back as 1826—the so-called heliographs—but the production was too difficult and complicated to give it great practical value.

In the year 1829 Niepce joined Daguerre, who was working in the same direction. The two labored together until the year 1833, when Niepce, full of grief over his twenty years of unsuccessful toil, died. Daguerre became the sole heir of his ideas, and a few years after Niepce's death the great problem, *to produce by the agency of light a permanent picture in an easy and practical manner*, was solved. In the year 1838 he placed the first proofs of his process before the three members of the French Academy,—Humboldt, Biot, and Arago.

The excitement was immense; everybody was anxious to learn how these pictures were made. Arago induced Daguerre to publish his invention, and the Government granted him a pension of six thousand francs. At the same time a pension of four thousand

francs was granted to the son of M. Niepce. On the 19th of August, 1839, the secret of the production of these pictures was given to the world in the public session of the Academy. The concourse was enormous. All the votaries of science and art of Paris were assembled in the Palais Mazarin. Thousands, who could not gain admission, besieged the doors. The busy newspapers soon spread the news of this discovery throughout the world, and in a few years disciples of the new art could be found in all the principal cities of Europe and America.

Daguerre accomplished his purpose in a way very different from Niepce and Wedgewood.

He employed as the sensitive substance the iodide of silver, which he produced by exposing a plate of silver to the vapors of iodine. The light impression which such a plate receives in the camera is at first invisible, but as soon as the plate is exposed to the vapors of mercury the picture appears with all its details.

This is a cardinal point in Daguerre's invention. While all the preceding experimenters tried to obtain a visible picture through the action of light only, he impressed the plate with a latent image, which only became visible by a secondary operation,—the development. In this manner light was only required for a short time to obtain a picture, and now it became possible to apply photography to living or moving objects.

While the new art—called Daguerreotypy, in honor of its inventor—held its triumphal march through Europe, there lived in England a rich private gentleman, by the name of Fox Talbot, who pursued the same object as Daguerre, but in a totally different manner. About the time when Daguerre presented his first picture to the members of the Academy, Talbot made a communication to the London Royal Society about a method to reproduce pictures by the aid of light. Following the experiments of Wedgewood, he took paper impregnated with common salt, and allowed it to float on a solution of silver. This paper, containing chloride of silver and the nitrate of the oxide of silver, was placed in contact with a copper-plate engraving and exposed to sunlight; it proved much more sensitive than that employed by Wedgewood.

The light penetrated the white places of the engraving and darkened the corresponding parts of the underlying sheet. A white picture on a dark ground was the result,—a negative.

The operation was then repeated; the negative took the place of the engraving, a piece of prepared paper was placed under it, and by exposing them to the sunlight a fac simile of the original print was produced. This operation can be repeated at pleasure, and thus a number of positive copies can be obtained from a single negative.

By this invention of Talbot photography entered the ranks of the reproducing arts.

After the discovery of Daguerre had become known, Talbot also tried to take pictures on paper by means of the camera. He floated the paper on a solution of iodide of potassa, and again on one of nitrate of silver; when it had become impregnated with iodide and nitrate of silver, it was exposed in the camera. In this manner a latent picture was obtained in a short time, which could be made visible by employing a development; for this purpose Talbot took a mixture of gallic acid and a salt of silver. The gallic acid reduces the salt of silver, and metallic silver finely divided forms a black precipitate, covering all the parts which have been exposed to light. A negative was thus obtained from which positives could be made in the manner described above. This process was published in 1841.

Talbot's pictures, however, compared with those of Daguerre, were so primitive and imperfect, that his process was merely considered as a curiosity, and attracted little attention. The rough texture of the paper was fatal to the delicacy which could be produced on the polished and mirror-like plates of Daguerre.

Soon, however, this was changed.

Niepce de St. Victor, a nephew of Nicephore Niepce, the friend of Daguerre, following the example of Herschel, substituted for the paper, glass plates, and made them the bearers of the sensitive film of iodide of silver. He coated these with albumen containing iodide of potassium, immersed them in a silver bath, and thus obtained a very sensitive and homogeneous film on which he could

take pictures much more delicate than those on paper; but still this process offered great difficulties.

In the meantime gun-cotton was discovered by Schoenbein and Boettcher. It not only proved itself a substitute for gunpowder, but was also employed in the healing art. It was found that this substance was soluble in a mixture of alcohol and ether, and that the solution, called collodion, left a transparent film after evaporation, which rendered important services as a sticking-plaster.

Legray, in 1850, was the first who tried to use this solution of gun-cotton, as bearer of the sensitive salts of silver, in place of albumen, after the manner of Niepce, but did not succeed. Archer and Fry, in England, were more fortunate. Their experiments were rewarded with complete success, and in 1851 Archer published a complete description of his new *collodion process*, which as to the beauty of its results was in no way inferior to the albumen process of Niepce, but far surpassed it in simplicity and certainty. Archer covered plane glasses with collodion containing salts of iodine in solution, immersed them in a silver bath, and thus obtained on the glass a delicate film saturated with sensitive iodide of silver. This plate, when used in the same manner as Talbot's paper, gave a negative of extreme sharpness and delicacy, and excellent positive pictures on paper could be produced in any quantity desired by the method described above. The discovery of Daguerre was now completely superseded. The collodion process spread rapidly, and in course of time was more and more improved, and is at present the one exclusively used.

Its rapid introduction is due partly to its delicacy, its easy execution, and partly to the advantage that the collodion pictures can be multiplied in a much simpler manner than the plates of Daguerre.

These circumstances alone, however, would not have been sufficient to give it the precedence over the process of Daguerre, as the collodion plates produce at first only a negative picture. It became necessary, therefore, to find a simple and easy way of printing positives with all the details contained in the negative, and this was finally reached through a special preparation of the

Talbot paper. The latter was covered with albumen, which Niepce had already successfully employed in the preparation of negative plates, and thus the albumen paper was made a medium for the production of excellent positives. Collodion for the negative and albumen paper for the positive process form now the most important bases of our photographic pictures.

Besides these successive improvements other circumstances contributed materially to the rising importance of photography.

The optical apparatus which served to produce the pictures in the camera were improved. Petzval invented the double objective in 1841, which combines extreme intensity of light with correct drawing.

It permitted the taking of objects with very short exposure, and now portraiture was brought to its high state of perfection.

Simultaneously with this, photographic chemicals were produced of great purity and cheapness. The qualities of those already in use became better known, and the imperfect ones were replaced by more efficient ones.

Fizeaut, Claudet, and Gaudin discovered the greater sensitiveness of the mixtures of iodide and bromide of silver. Goddard also introduced mixtures of iodide and bromide of silver into the collodion process.

Herschel suggested the use of hyposulphite of soda, which removes the sensitive salts of silver from the photographs, and thus fixes the picture in a permanent manner.

Fizeaut introduced the gold toning bath, which removes the unpleasant color and makes them more permanent.

It is owing to these and other numerous discoveries that photographic operations have become so easy and practical, that any moderately skilful person can become an expert in a short time. The consequence has been that an immense number of people devoted themselves to the new art in the expectation of making money rapidly and without trouble.

The introduction of the carte de visite style made photography popular, and the public rushed to the galleries, which sprang up everywhere like mushrooms. In the same manner did the manu-

facture of photographic apparatus and chemicals gain in importance.

Optical establishments were started for the exclusive production of photographic lenses. Cabinetmakers devoted their whole attention to the making of photographic cameras, picture frames, and presses; and other accessories required special factories to supply the growing want. At present millions enjoy directly and indirectly the fruits of the beneficial invention of Daguerre and Talbot.

Many of their followers are now simultaneously investigating the hitherto unexplained physical and chemical processes of this art, to find new branches for its use, and to do away with the imperfections which still exist. Every day new suggestions are made, and a large number of photographic journals are published to register the new discoveries and to announce them to the world. It is not at all impossible that a new and more perfect process may supersede that of Talbot in the same manner as he supplanted Daguerre. Quite a number of interesting experiments have already been made by Niepce de St. Victor, Becquerel, and Poitevin, to produce photographs in their natural colors, the fixing of which, however, has not yet been accomplished. More important and successful are the experiments to replace the expensive salts of silver required by the present process by cheaper materials.

Herschel employed first the salts of iron, Niepce de St. Victor and Burnett the salts of uran, and Mungo Ponton the chromates, as sensitive substances. The trials hitherto made have already produced remarkable results.

Poitevin's Carbon Printing Process particularly deserves in our opinion the greatest consideration of all the recent methods of printing. It is based on the sensitiveness of chromate of potash.

The aim is now to increase the productiveness of photography to an unlimited extent by combining it with lithography and metal plate printing. Fizeaut was the first who tried to prepare a daguerreotype plate with acid, and thus make it suitable for copperplate printing. As early as 1844 he furnished such heliographs. Fox Talbot succeeded in transferring the photographic picture on

steel, and made a photographic steel-plate engraving. Poitevin tried to produce photolithographs, a process which has recently been highly improved by Osborne, Toovey, James, Asser, Lemercier, Burchardt, and others. The problem to reproduce line drawings has been solved and is already generally employed. The rendering of the half tones, however, still offers difficulties, for the removal of which numerous investigators are zealously at work.

While this work is leaving the press, we are informed of a new and important discovery in this respect—the Woodbury Photo-Relief Printing Process—which seems to pave the way for a great revolution in our photo-mechanical printing processes. At the same time we receive samples of new photographic optical instruments, invented by Busch, Steinheil, Ross, Dallmeyer, and Zentmayer, which increase the usefulness of photography in a wonderful manner.

An appendix to the Handbook will report the particulars of these new discoveries. In these pages I only intended to give a comprehensive picture of the gradual development of photography.

H. VOGEL.

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THE ART OF PHOTOGRAPHY, OR PHOTOGRAPHIC ÆSTHETICS.

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THE

PRACTICE OF PHOTOGRAPHY.

CHAPTER I.

THE ARRANGEMENT OF THE GALLERY.

THE photographer, like every other artist or mechanic, requires for his labors a place where he is protected against the influences of the weather.

These labors are of various kinds,—partly mechanical, as the cutting and cleaning of plates; partly chemical, as the preparation of collodion, silvering of paper, developing, intensifying, fixing, and washing; partly physical and optical, as the focussing and exposing; and, finally, partly artistic, as the posing of the sitter, the arrangement of the drapery, the illumination, and the negative and positive retouching. It is evident that these operations cannot all be carried on in the same room, particularly as some of them demand diametrically opposite conditions for their success. The taking of the model requires much light, while the preparation of the plates must be carried on in almost total darkness.

Every photographer needs therefore a suite of rooms, which however frequently appear reduced to two,—the studio and the dark-room.

In assigning proper localities to the different work to be performed, particular attention should be paid to separating those branches which are in their nature antagonistic.

The silver bath should not be evaporated in a room where prints are being mounted. The plate while being fixed must not be exposed to the danger of being sprinkled with the developer, not to mention a hundred other precautions.

The necessity for a division of labor and space increases with the magnitude of the establishment, in order that each particular kind of work may be carried on independently.

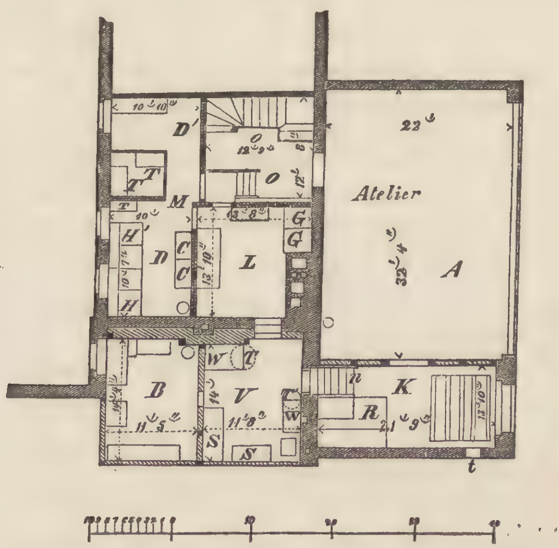
A drawback to the proper arrangement of photographic ateliers is generally met with in the fact that they are located in the upper stories of houses, which were originally designed for other purposes. The consequence is that they must accommodate themselves to the already existing proportions, and this can only be done by sacrificing many advantages.

We find therefore the greatest diversity in the arrangement of photographic galleries. Only one principle in the above stated necessity of a division of labor seems to be persistently carried out, namely, the separation of the negative and positive processes.

As examples of the arrangement of a gallery, we will give two practical illustrations. The one is the photographic atelier of the Royal Academy of Industry at Berlin, the other the atelier of Rabending & Monckhoven at Vienna. Any one who desires to arrange an establishment will find in these descriptions a guide, although local conditions will often compel a modification of these plans.

The photographic atelier at Berlin (Fig. 1) consists of a glass-

FIG. 1.

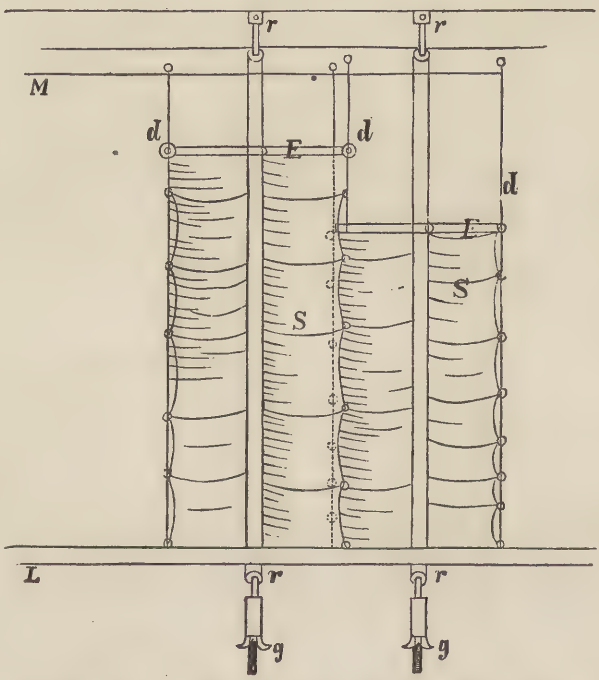


house, A, 32 feet long by 22 feet in width. The height of the front glass wall or sash is 10 feet 6 inches; the rear wall is 16 feet high.

The roof is only glazed for a distance of 16 feet. The atelier itself does not face exactly north, but north-northwest, conforming to the building on which it is erected. In the summer-time the afternoon sun shines on the glass-house, an evil which can only be partially remedied by awnings and curtains.

The curtains are arranged according to the system of Loescher & Petsch, which appears the most rational and has already been adopted by several Berlin photographers. It consists of side curtains which can be moved in a vertical direction, and top-light curtains which move parallel to the inclination of the roof. A section of the side curtain is represented in Fig. 2, and Fig. 3 represents one of the top-light curtains with the cords for moving it.

FIG. 2.



The curtains are 2 feet wide and overlap each other like the shingles of a roof, in order to exclude the light completely (see Fig. 2.) The guides are thin wires, *d*, on which the iron rods, E, which carry the curtains, slide.

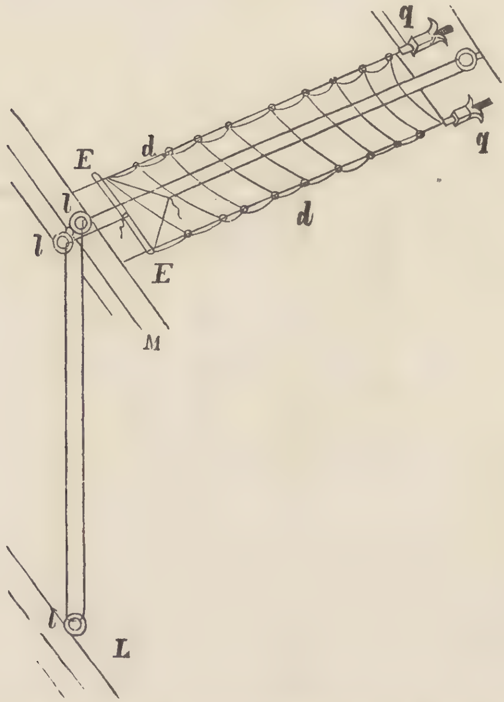
It is easy to darken the whole atelier, to make openings of 2, 4, or 6 feet in width, and of any suitable length, and to modify the direction of the entering rays in various ways.

The cords for the side curtains pass over the rollers *r*, *r*, *r*, *r*, which are fastened near the roof to the board *M*, and at the floor to *L;* the cords can be tightened by the screws *g*, *g*. The wires *d*, *d*, of the side curtains, hang down loosely, while those of the roof admit of tightening by the screws *q*, *q* (see Fig. 3). The cords of the top curtains pass through porcelain rings, *l*, *l*, which are fastened to *M* and *L*.

The curtains are made of very opaque double blue material.

The above system was especially designed for portraiture, which however is not the class of work done at the Academy; still it does excellent service in the taking of plastic objects.

FIG. 3.



Immediately adjoining the glass-house, and on the same floor with it, is the copying-room, *K* (see Fig. 1), with a window facing N. N. W., and a top-light one-half the size of that which covers the atelier. A sliding door leads to the latter, which is opened when it becomes necessary to remove the camera to a great distance from the object which is to be taken; by this arrangement the apparatus can be removed 45 feet from the opposite wall of the glass-house.

The width of the copying-room is only 14 feet; the length and height are those of the atelier. The top-light is, for copying purposes, a little too high. In order to bring the frames nearer to the light a movable platform of wood has been constructed, which by mechanical means can be elevated to a height of 8 feet, or lowered at pleasure.

The copying-room is divided in two parts. The back part, *R*, serves as a dark-room, where the papers are placed in the frames, and where the progress of printing is examined. The fresh copies are also kept in this room. The front part serves for exposure. A side door, *t*, leads to the roof, where, when necessary, the work can be carried on in the open air.

Immediately adjoining the copying-room, but a little higher situated than the latter, and connected with it by a staircase, are the rooms for the further manipulation of the paper prints. 1st. The wash-room, *V*. 2d. The finishing-room, *B*. The former contains two troughs lined with asphaltum. They are 5 feet long by $2\frac{1}{2}$ feet wide. They rest on the tubs, *T*. One of these troughs is for washing the fresh copies; the other for washing the fixed prints. An opening carries the wash water with the silver contained in solution into the tub, *T*. Another opening, which can be closed, leads the waste water into the street.

The tub *T* receives the water containing soda, and T' those which are free from this substance.

The tables, *S*, *S*, are for silvering paper; the toning is done in the light part of the copying-room.

The adjoining space, *B*, is used for mounting, retouching, and rolling the pictures, and also serves as a store-room for paper, chemicals, &c.

We now proceed to describe the apartments devoted to the negative processes. Here we have, first, a small laboratory with top-light, *L*, in which the chemicals are mixed, the baths and other substances tested. Evaporations, and all other chemical processes are also carried on here.

In the room next to the furnace are two places for evaporation, *G*, *G*; the one for liquids containing silver in solution, the other for the solutions containing chlorine (gold solutions, &c.).

The reduction of the silver residues of the different melting processes is finally done in the large laboratory of the Institution.

D, *D* is the dark-room for the preparation of the plates. By a curtain, *M*, it is divided in two parts, and a space, *T*, *T*, is partitioned off in the centre for the preparation of dry plates.

In *D'* the plates are cleaned, and all the work connected with it is done here.

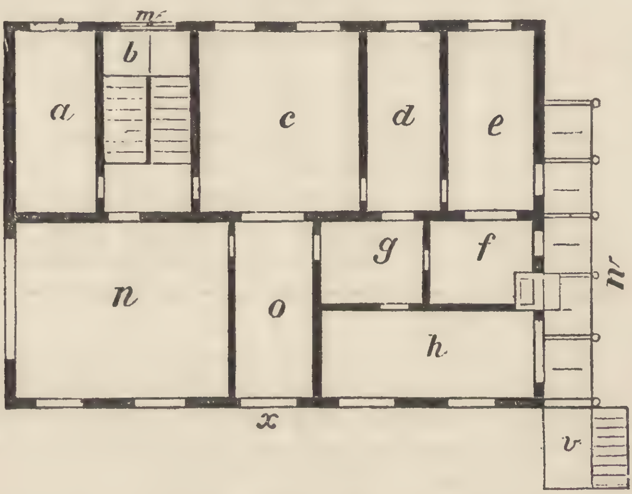
C, *C* is the table with the silver bath, *H* the developing, and *H'* the fixing trough. They are separated by a partition, and each trough consists of two parts. From the left part the rinsing waters, which are rich in silver, are carried in a tub underneath the table; the right hand part serves for the final washing, and the waste water is carried off into the gutter. The width of each of the four troughs, which are lined with asphaltum, is 2¼ feet. Gas and water-pipes run of course through the whole establishment.

P are shelves for plates.

The dark-room communicates with the atelier by the entry, *O*, *O*.

Perhaps it would have been better if the laboratory, *L*, had been taken for the dark-room, but the arrangement of the building would not permit it, and the peculiar construction of the basis on which the atelier was constructed caused unusual difficulties in the proper distribution of the different localities.*

Fig. 4.



GROUND FLOOR.

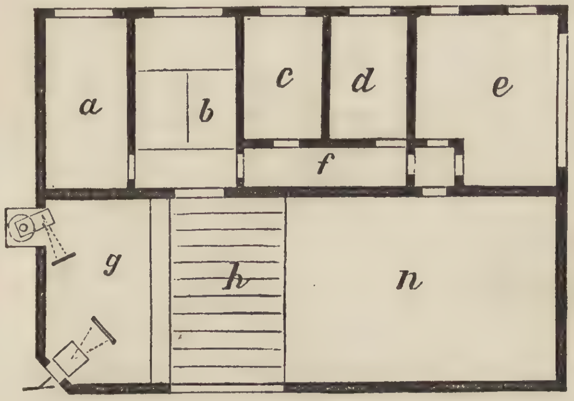
a, Retouching-room for positives; *b*, staircase; *c*, saloon; *d*, counting-house; *e*, negative-room; *f*, room for negative retouching; *g*, waiting-room for the servants; *h*, mounting-room; *n*, laboratory; *o*, entry; *v*, copying-room; *w*, glazed gallery.

The gallery of Rabending & Monckhoven has the advantage of being built for photographic purposes.

* It will be noticed in Fig. 1 that the various rooms are not on the same level, and communicate by steps with one another.

It is a two-story building, in the second story of which the glass-house is situated. It stands perfectly free, being surrounded on all sides by a spacious yard.

FIG. 5.



SECOND STORY.

a, Toilet room; *b*, staircase; *c*, store-room for paper; *d*, plate-room; *e*, dark-room; *f*, entry; *g*, enlarging-room; *h*, glass-room; *n*, tunnel.

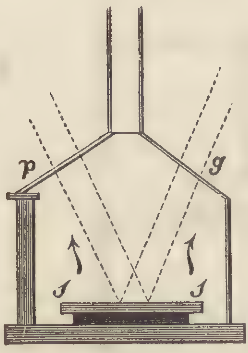
On entering the building, the elegant corridor, *o*, leads to the waiting-room, *c*, next to which is a smaller waiting-room for servants, *g*. To the left is a room, *n*, the laboratory, next to which the staircase leads into the second story to the glass-house, *h*. Back of the glass-house and facing south is a room, *g*, for enlargements; next to it is a dark space in which the apparatus is placed. In the same room is a closet for the small unvarnished negatives intended for enlargement.

The ordinary work of the positive process is carried on in an adjoining building which is connected with the main edifice by the glazed gallery, *w*. Probably an enlargement of the establishment made this addition necessary.

The glazed gallery, which is open on one side, can be used for copying in the open air in bad weather. Not far from the positive-room is a smaller one, *f*, for negative retouching. The retouching-desk, *p* (Fig. 6), which is placed near the window, is made of a large plate of ground glass as wide as the window. Below this plate is a mirror, *s*, almost of the same size, and placed nearly horizontal; the mirror reflects the light of the sky on to the ground-glass on which the negatives are laid. The plate is covered with suitable boards in such a manner that only that part of the nega-

tive which is to be retouched is illuminated. The mirror is surrounded by a transparent casing.

Fig. 6.



The other apartments on the first floor, the separate purposes of which can be seen from the description, are all devoted to the different branches of the positive process.

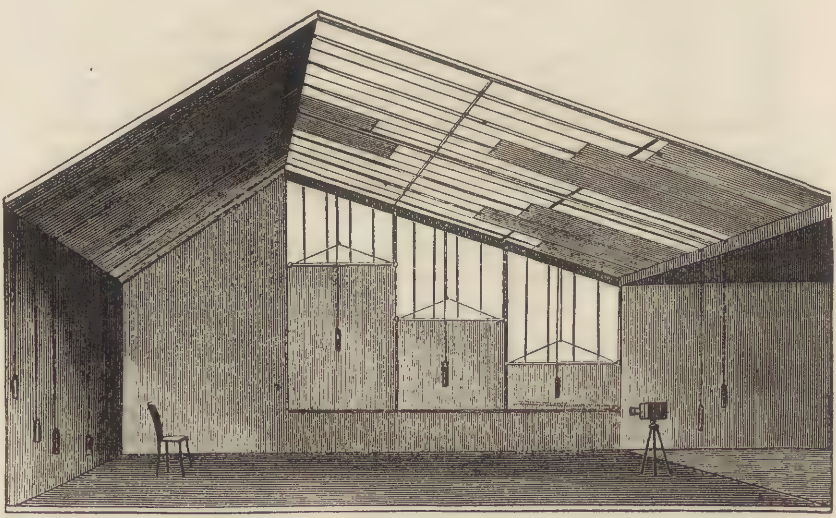
The laboratory for the negative process, *e* (Fig. 5), adjoins the atelier in the second story. The light enters through reddish yellow windows. Next to it is the store-room for negatives.

THE GLASS-HOUSE.

The glass-house is that part of the photographic establishment in which the picture is taken.

We have given our readers in the foregoing descriptions the arrangement of the gallery in two different kinds of glass-houses, which in their construction differ materially, and are, so to say, the

Fig. 7.



types of two different systems. The one is the atelier with north front, of which the Berlin atelier is a specimen; the other the so-called tunnel atelier. In the former the apparatus is placed with

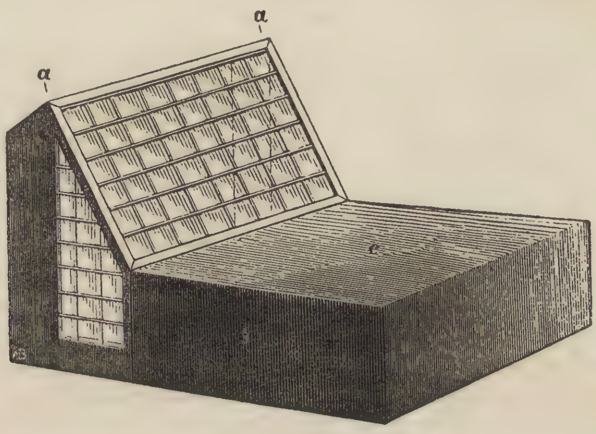
the model in the same glazed space. The visional direction of the apparatus generally coincides with the longest diameter of the room. The principal glass wall runs exactly from east to west, and serves as a support for a more or less steep and wider glass roof.

The model is generally seated at the side.

Fig. 7 represents the interior of such an atelier, after the American and Berlin model.

The tunnel atelier consists of two essentially different parts,—a dark one in which the apparatus is placed, and a glazed one for the model. Fig. 8 represents the exterior of Monckhoven's tunnel atelier. It is a peculiar structure, with a very wide glass front facing north, about 26 feet in length, and an eastern glass side of about 11 feet in width. Adjoining the glass roof is a covered

Fig. 8.



space for the background, and a low and rather dark space, the tunnel, for placing the apparatus.

The person is placed in such a manner that the part which is to be portrayed is turned towards the north—*i. e.*, the face is turned towards the broad glass roof.

The steepness of the roof facilitates the running down of rain and snow, and the high back wall acts as a protection from the sun.

CRITICISM OF THE ATELIER TUNNEL.

Experience has proven that in all constructions of ateliers the principle of excluding direct sunlight, and of working with the diffused light of heaven, is found to be the best.

The reasons for this we shall explain in the second part of this book.

To exclude direct sunlight the glass surfaces face the north as much as possible, and to obtain the largest amount of diffused light the glass-houses are erected on the tops of high buildings, or in places where the horizon on the glass side is free from objects which would obstruct the light. In cities this is not always possible, and frequently a considerable portion of the vault of heaven is cut off from view. The light which is reflected from buildings is not always useless, but its intensity is a different one. Sometimes it is lighter (when reflected from a white wall) or darker, and this circumstance becomes an annoyance when the light is to be distributed properly by an arrangement of curtains.

Not only the quality and quantity of light is essential in the use of a glass-house, but also the direction in which it strikes the sitter has to be taken into consideration.

In the second part we shall give three photographic portraits as illustrations, taken with front-light, top-light, and side-light, and it will be noticed that front-light is the most unfavorable, while side-light is the most favorable. Leaving the explanation of this point for the æsthetic portion of our work, we will only mention that nobody should take a portrait exclusively with side-light, but that in the best portraits from the most celebrated ateliers this light predominates. From this standpoint we cannot advocate a construction like Monckhoven's in which the front-light predominates; it would appear more useful when, as shall be explained further on, the side-light could be widened and the front-light made narrower.

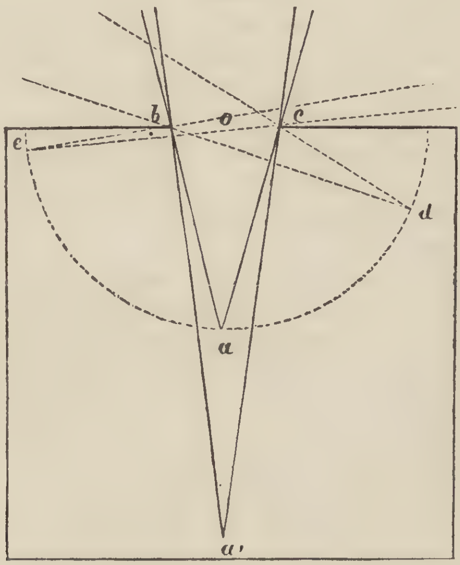
For the better understanding of the distribution of light in an atelier, we must explain the main principles of illumination in a glazed space.

We take for instance a room which receives its light through a window from the clear blue sky. Experience teaches us that the light in such a room is very unequal in different places; the further an object is removed from the window the darker it will appear, and *vice versa;* but, besides the distance from the window, the position towards it becomes of importance. A point close to the window will appear darker than one equally far removed, but opposite to it.

Let us explain the cause of this appearance. Excluding direct sunlight, the sky is the only source of light which illuminates the objects in the room, and an object will be lighter in proportion to the number of rays it receives from the sky.

Taking for instance the point *a* (Fig. 9), which is opposite a circular window, the latter receiving a cone of rays of the size of the diameter of the window. We take a second point, *a′*; this point is illuminated by the cone *b*, *a′*, *c*, which is considerably smaller. Still more pointed appears the cone which illuminates the point *e*, and thus it is explained why *a* will appear brighter than *a′*, and *a′*

Fig. 9.



brighter than *e*. The opening of the cones of rays, or the angle which is formed by drawing lines from the point in question towards the window, gives us a criterion of its relative brightness. I call this angle the angle of light.

When we take a point on the wall containing the window, the angle will be reduced to a line, and would be absolutely dark if it did not receive light by reflection.

It is evident that not only the wall in which the window is, but also every other point in the room receives this reflected light from walls, floor, and ceiling. Every point in the room, the wall with the window excepted, is struck by two different masses of light.

1*st.* The direct light of the sky, the quantity of which is proportionate to the extent of the effective spherical surface of the vault of heaven.

2*d.* The reflected light of the walls, &c., &c., the nature of which is more complicated.

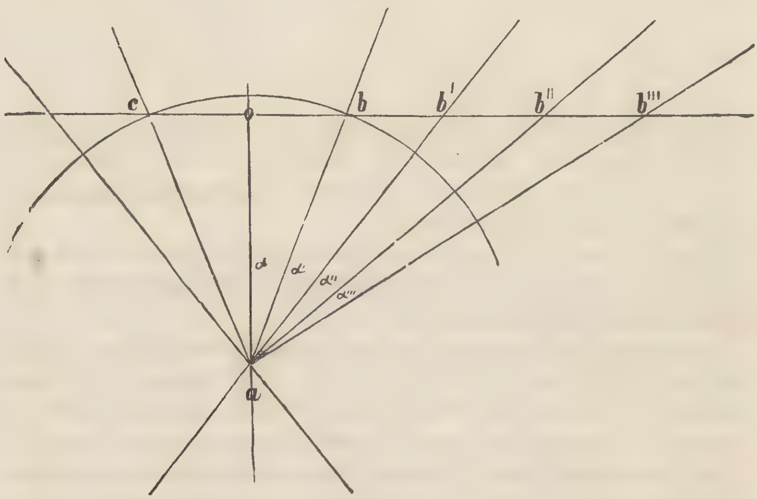
Let us look aside for the present from the reflected light and consider the action of direct sunlight. The illumination produced from this source we will call, for the sake of brevity, the *direct brightness.*

The direct brightness of a point in the room is, as has been explained above, dependent on its position to the window, and on the size of the latter.

For the better explanation of this point we will start from the plainest proposition, and consider the brightness of a point directly opposite to a small round window. The larger the window, the larger will be the angle of light. Suppose the angle of light should be small, then the brightness of a point will be proportionate to the surface of the window. In similar figures, the surfaces are proportioned as the squares of similar lines, and accordingly the brightness would be proportioned as the squares of the diameters of the windows.

A window twice as large, be it round or square, will give for the same point four times as much light, and one of three times the size nine times as much. With larger window openings the increase of brightness by increasing the opening is not so marked. We take for instance a point, *a* (Fig. 10), which is opposite the opening, *c*, *b*,

FIG. 10.

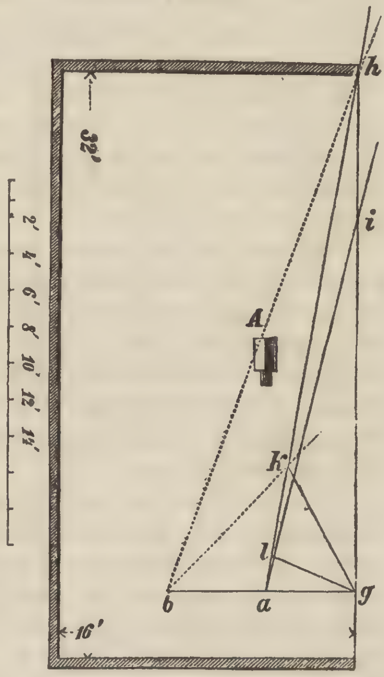


in the otherwise darkened glass-house. Half the angle of light would be, in this case, α, and when we increase the opening successively to twice the size, $o\ b'$, or three times, $o\ b''$, and four times,

$o\ b'''$, the angle of light at a will be increased by the piece a', a'', a''', which, as will be seen by the figure, increases less rapidly than the size of the window-opening. We can draw from this at once a practical conclusion.

If in a glass-house of 32 feet in length, a person, a (Fig. 11), is placed 5 feet from the glass side and 4 feet from the background, and the glass side is open from g to h, we will have a criterion of the amount of light which the person receives by constructing the angle h, a, g. The portion of the vault of heaven which is cut by the angle h, a, g, determines the brightness of the point a.

Fig. 11.



If the length of the atelier should be 24 feet instead of 32 feet, that is, if it terminated at i, then the brightness would be determined by the angle i, a, g, all other circumstances being equal. A glance at the figure will show that the angles i, a, g, and h, a, g, are not very different—*i. e.*, that in this especial case the extension of the glass wall by 8 feet beyond i (by the piece i, h) would not secure any great advantages, particularly as the light which strikes the glass side h, i, under a very oblique angle, is for the most part reflected. Suppose we take two points, a and a' (Fig. 8), the distances of which from the small window are different.

As we increase the distance from the window we decrease the angle of light.

A simple mathematical consideration leads to the result that the brightness of two points, which are located opposite a window, *decreases at the same ratio as the distances from the window increase.*

When we remove an object twice as far from the glass side of the atelier, we must, in order to secure the same brightness, open the curtains twice as wide, in order that the light-giving glass surface be four times as large as when the object is near the glass

side, or we must extend the time of exposure fourfold in order to secure the same result. When the window is very large the brightness will not decrease quite as rapidly with an increase of the distance—*i. e.*, at twice the distance the brightness will be a little more than one-fourth, at three times a little more than one-ninth.

From the above considerations we may draw a practical conclusion and answer a question which of late has been asked quite frequently, namely: "*Which is the most practical, a high or a low atelier?*" But we have to answer another question first: For what purposes is the atelier intended?

An atelier may be perfectly adapted to the taking of single portraits, while it may be unsuited to the taking of groups or reproductions, and *vice versa.* Ateliers like Reutlinger's or Adam Salomon's, are excellent for taking single portraits, while they are unsuited to taking groups.

The reason of this is easily explained. In copying large paintings or drawings we require a uniform illumination over the whole of the original, while with a single portrait the reverse is the case. The head, which is the principal object, should be lighter, while the other less characteristic parts should be kept in half shadow. These are artistic qualities which in a high degree are visible in the portraits of Adam Salomon, and less strikingly in those of Carl V. Jageman in Vienna.

If we should try to take a group under the same conditions of illumination, only one person would appear properly lighted, while all the rest would be in half shadow and scarcely visible.

To answer therefore the above question we must consider first the purpose for which the atelier is constructed; and I will take the simplest case first,—*the construction of an atelier for single portraits.*

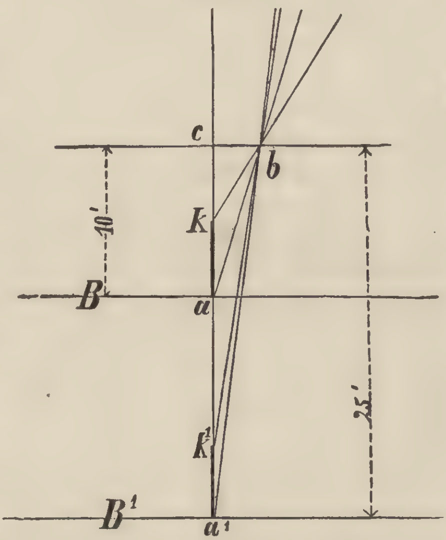
Suppose we have an atelier (Fig. 12) about 25 feet high, and in it an object, for instance a person, a', k', 5 feet high. Above the person is an opening, b, c, in the glass roof of a given size. The distance of the head from the roof would be equal to 20 feet, and the distance of the floor = 25 feet; hence the brightness of the two would be as 400 to 625 = 16 to 25, or nearly as 2 to 3.

Suppose, further, we have an atelier 10 feet high, all other conditions being equal. In this case the head, k, would be 5 feet distant from the floor, and the feet, a, = 10 feet; the brightness of the two would be as 1 to 4.

It shows how important these differences are. In the first case, in a bright atelier, the head receives only one and a half times as

much light as the feet; in the second case four times as much. What is the consequence? In the former case we have slight contrasts of light and shade, while in the latter they are very strong.

FIG. 12.



In a portrait the head is the principal object; the head should receive the main light. A contrast of light and shade between hands and feet in the proportion of 2 to 3 is not sufficient to mark brilliant contrasts in the picture. A difference of 1 to 4 gives much more effect. From this standpoint a low atelier has the advantage for taking single portraits. As an example of such low ateliers I would mention those of Adam Salomon and Reutlinger in Paris.

The case is quite different when we take *groups* or *drawings*, where an illumination which is equally divided over the whole surface is desired. *High ateliers* are in this case desirable. But we can, in a low atelier, produce the same effect when the *glass roof* is sufficiently wide, or of a width equal to the group.

When, on the other hand, we wish to obtain in a high atelier the same effects as in a low one, we will do well to place the persons under screens or curtains, which are placed at a height of about 10 feet above them.

While explaining these principles we, for the present, do not take into account the light which is reflected from the walls, nor the amount of light lost by reflection in passing through the windows. Any one who has read the preceding directions attentively will find no difficulty in solving different problems in regard to the brightness of a given point in the atelier. For small openings of light it is easy to calculate the brightness of a point in the room according to the formulæ given hereafter, but with larger glass surfaces the construction of the angle of light will give the best criterion.

For this purpose a drawing of the atelier (or a part of the same

containing the point in question, and the area of glass surface transmitting the light) is made in ground-plan and vertical section, and the angle of light is constructed both in the vertical and horizontal plane.

From the above principles a criticism on the construction of the atelier follows as a matter of course.

Let us take as an example the atelier (Fig. 11) which has a northern front. It is 32 feet long and 16 feet wide; it shows closed walls and a glass front, *h*, *g*. The scale is given. Suppose a person be at *a*, 5 feet from the window and 4 feet from the rear wall, the glass side to be open from *g* to *h*, or 28 feet. We will get the effect of the 28 feet glass side by constructing the angle *h*, *a*, *g*. Suppose we take instead of the long glass side, *g*, *h*, an inclined one, *g*, *k*, of only 8 feet in length. The angle, *k*, *a*, *g*, will be exactly as large as the angle *h*, *a*, *g*, *or the small glass side of only* 8 *feet will admit as much light as the large one*, *g*, *h*, *of* 28 *feet in length.*

Even a glass side, *g*, *l*, of only 5 feet in length, would give as much light on a person at *a*, and be unprofitable only in so far as seen from *A* (where the apparatus has been placed); a part of the field of view would be cut off by the edge *l*.

We have shown that for taking the picture of a person at *a* the large glass side of 28 feet in length can be replaced by a much smaller one placed at an inclination, the size of which need only to be 8 feet, without detriment to the brightness of the illumination *What holds good for the side applies with equal force to the roof. The surface of* 28 *feet in length can be replaced by an inclined one of only* 8 *feet.*

When we construct an atelier with such a glass side and an analogous roof, we will have a space which apparently equals in brightness the large atelier of 32 feet in length.

Such an atelier would resemble the following figure. (Fig. 13.)

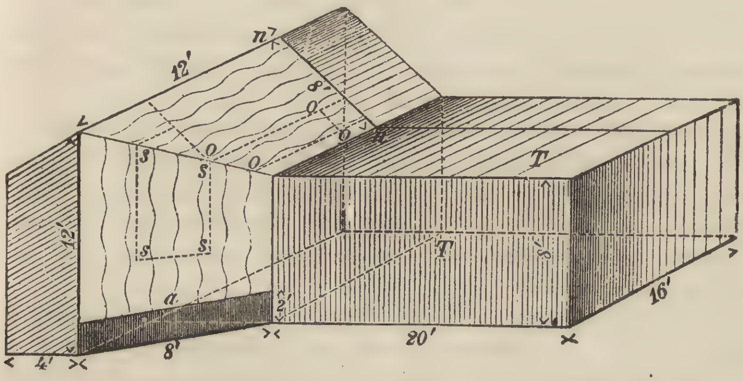
The parts not shaded are glazed; the others are dark; the apparatus would stand in the dark parts, *T*, *T;* the person would be at *a*, near the glass side. The depth of the glass roof we have taken at 12 feet. For single portraits this would not only be sufficient, but for most cases in excess, and only in exceptional cases the whole roof could be employed.

Starting from simple principles of illumination we have reached an atelier construction which has often been adopted, although in different proportions. It is the so-called *tunnel atelier*, and we have shown that for taking *single portraits*, observing the *explained*

conditions, it answers every purpose in regard to the quantity of light as well as a large north front atelier. For amateurs and small photographers, but only for these, such a building would answer every purpose.

The best position for the side is due north. In this way the side light is, as the main light, most effectually excluded from the

FIG. 13.



direct rays of the sun. The roof must be protected by awnings from the direct sunlight. Where the saving of room is an object, the depth can be reduced to 16 feet. Such an atelier would answer for single portraits, and would recommend itself on account of its cheapness; still it has disadvantages when compared with a north front atelier. In the first place, the person always receives the light from the same side. In the above instance from the right, while an atelier fronting north admits of illumination from right or left by placing the person so as to face east or west.

This disadvantage is not of great moment. In all of Reutlinger's pictures the light comes from the right-hand side.

A greater disadvantage shows itself when the person is not, as we have proposed, seated near the glass side, but is removed from it.

Suppose a person is placed at b (Fig. 11), twice as far from the glass as a, we will see by drawing the lines b, h, and b, k, the light-effect which the two sides g, h, and g, k will produce; and here it becomes evident that the angle h, b, g is much larger than k, b, g, *or that for a point removed from the glass side the illumination is in a north front atelier much more favorable.*

In a tunnel atelier we are confined to the space in the immediate neighborhood of the light, while a north front atelier permits of greater depth, *and the latter gives not only a greater space for*

artistic arrangement, but also a decidedly better light for taking groups.

The advantages of a north front atelier are easily understood therefore.

SIZE OF THE ATELIER.

What dimensions shall we give the atelier?

We have to consider, first, another point,—*i. e.*, distance.

We need, for a picture of *carte de visite*, or for one of half size, lenses of different focal length, and also a different distance from the apparatus to the object. The longer the focal length of an objective, the greater must be the distance between the model and the camera. In a tunnel atelier this can be accomplished by extending the tunnel. In a north front atelier, where the apparatus stands in the glass-house, it is necessary that this should have the proper length, provided that we cannot remove the apparatus into an adjoining apartment.

The length of a glass-house, where no adjoining rooms are at the disposal of the operator, should not be less than 20 feet.

The smallest width, when we do not wish to be cramped in our operations, should be 10 feet. In such a room standing figures, for which the greatest distance is necessary, could be taken only of card size. For standing figures of larger size such an atelier would not be sufficient. For such figures in cabinet size at least 24 feet would be necessary, and for $8\frac{1}{2}$ by $6\frac{1}{2}$ plates at least 30 feet would be required.

For busts, &c., a shorter distance would suffice.

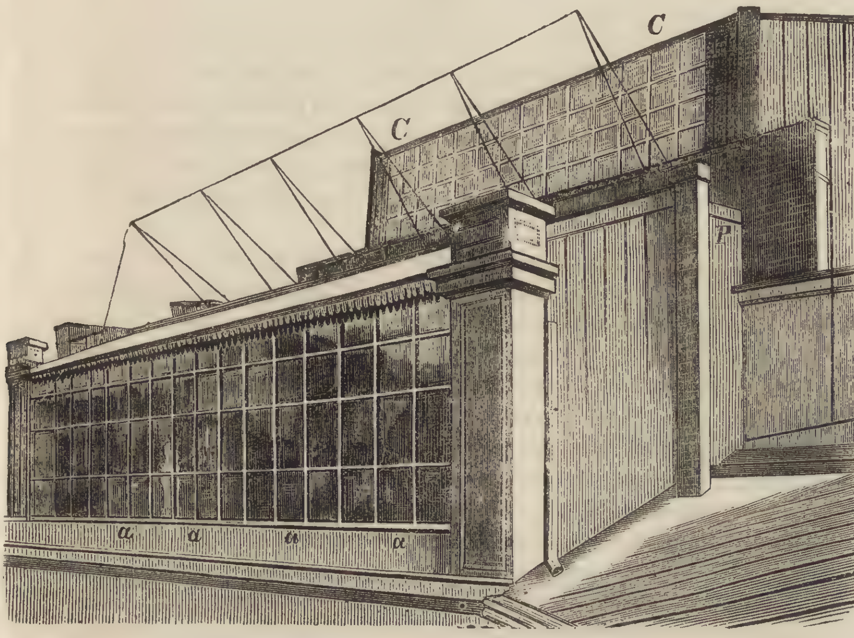
Groups, which besides the height extend in breadth, require still larger distances than standing figures, and want besides a corresponding width. An atelier 40 feet long and 20 feet wide would however answer almost all requirements. The height of the glass side we would recommend should not exceed 10 feet (Adam Salomon, whose light-effects are so much praised, has an atelier 8 feet high). The glass roof must ascend to the rear, like a desk, in order to shed the rain-water. I would recommend for a distance of 10 feet an ascent of 2 feet. The depth of the glass roof itself should be nearly equal to the depth of the atelier. The lighting of the shadows will thus be under perfect control by opening more or less the top curtains.

Fig. 14 gives the outside view of Milster's atelier in Berlin. It is 32 feet in length and 23 feet in width. Above, the iron rods are visible on which the awning is fastened.

Back of this is a smaller glass-house, *C*, *C*, of a very simple construction, and 10 feet high, for printing purposes.

The main atelier should be constructed of glass and iron. It is expensive, but it is solid. The printing-room may be made of glass and wood. The platform, *P*, is for printing in the open air. For the interior arrangements the curtains require the most careful attention.

FIG. 14.



Only in exceptional cases the photographer will have to use the whole glass side and the roof to light his sitter; generally he will have to reduce the light by means of curtains. Formerly simple curtains, which moved horizontally on rings and wires, were considered sufficient. Lately, however, more complicated systems have come into use.

White and lace curtains are superfluous. The latter do not prevent the light from entering, but only modify it. The same effect is produced with dark curtains by narrowing the opening through which the light enters. We would remark, in conclusion, that the curtains must be carefully handled. In damp weather the cords should be slackened to prevent their snapping, and even the most perfect arrangement will still leave something to be desired.

The American ateliers are generally *very high*, and, in this respect, well suited for taking groups and drawings. For the taking of single portraits, however, they are inferior to low ateliers. We know very well that there are high skylights in America in which splendid single portraits have been made, but it does not follow by any means that the high skylight is advantageous for taking single portraits. We refer to what has been said previously on this subject.

OF THE GLASS.

For the glazing of the atelier a good and as nearly colorless glass as possible should be selected. It must be free from manganese. Glass containing the latter substance will in course of time turn yellow and obstruct, in a measure, the passage of the actinic rays. This is the reason why in many ateliers the light gets worse from year to year.

Blue glass is not to be recommended. Mr. Gaffield has shown that blue glass obstructs the passage of the chemical rays to a much larger extent than white glass.

Ground-glass is also sometimes employed for glazing the skylight. The roof of Adam Salomon's atelier, for instance, is glazed with this substance. It absorbs about 50 per cent. of light, while white glass will absorb only about 5 per cent.

To the photographer who does not know how to manage his curtains in order to produce the best effect, we would recommend to cover his skylight with ground-glass. It modifies and mellows the effect of too strong a front-light. Ground-glass also is advantageous to prevent reflexes of sunlight in certain parts of the atelier which are exposed to direct sunlight. Ordinary glass, however, by being covered with a thick starch paste, will act similar to ground-glass. A wash of warm water will easily remove this covering.

To keep the glass clean on the outside is of great importance. When the rain does not perform this duty the glass should frequently be washed. A hose attached to the water-pipe is very serviceable for this purpose.

VENTILATION.

Frequent change of air is necessary. For this purpose the atelier of the Academy is provided with four small windows, below the side light near the floor. (See Fig. 15.) Besides, the rear wall of the atelier is provided with four large openings at its highest point (ventilators).

CHAPTER II.

OF THE MANIPULATIONS.

THE NEGATIVE PROCESS.

SECTION I.

THE PREPARATORY MANIPULATIONS.

Rules of Precaution.

A PIECE of paper and a lead-pencil are sufficient for a draughtsman to reproduce or to make the picture of any object. He spreads the paper, he points his pencil, and all his preparations are made. The work can commence.

It is quite different in photography. Even to make the smallest and least important picture requires a quantity of apparatus—camera, tripod, lenses, plate-holder, dishes, bottles, basins, and a number of solutions—silver-bath, developer, fixing-bath, &c., and the preparations, which, for the draughtsman, are made in a few seconds, may, for the photographer, require hours. He has, however, the other advantage, that the taking of the picture will be accomplished in a few minutes, while a draughtsman would have to work hours or days, and then he would have but one picture, while the photographer will have a plate from which he can produce hundreds or even thousands of prints.

The preparation is therefore the main thing in photography, and it must be made with the greatest accuracy and cleanliness on the one side, and with presence of mind, knowledge, and taste on the other, if we expect to realize a satisfactory result.

What advantage is there in the best collodion, and the cleanest and most carefully prepared plate, if the person represented is illy posed or badly illuminated? What advantage, on the other hand, is the most tasty arrangement when the silver-bath refuses to work properly? And what shall I do with a plate prepared with

the best material, clean and perfect in every particular, and the object represented be ever so beautiful, if the lens does not work properly, or the focussing has been carelessly performed, and the picture looks distorted and does not possess sufficient sharpness?

Each separate branch of the preparatory work, and there are many of them, must be carried out with the greatest care. Nothing must be forgotten, and nothing must be considered as being of little moment. And whoever does not go to work, in this respect, with the greatest and most conscientious care, will never become a great photographer, but always remain an incompetent.

I would advise beginners in particular not to attempt to take a picture until they feel fully convinced that all the apparatus and chemicals, from first to last, are in a normal state and ready for use. How often has it happened to me, with my scholars, that a plate has been coated with collodion and has become dry because the dipper was not handy? How often has an exposed plate been spoiled because the developer was not handy or had not been made at all, not to mention numberless other "accidents."

The preparations are, according to the nature of the work, very different. They are different for the negative and different for the positive process, different for the carbon print, and different for the silver print, or the enamel process. We will first consider the process on which all the others depend,—*i. e.*, the negative process.

A. PREPARATIONS IN THE GLASS-HOUSE.

The preparations in the glass-house are twofold:

1. The arrangement of the object which is to be taken;
2. Arrangement of the optical apparatus.

The arrangement of the object which is to be taken is sometimes very easy, as the placing on a board of a print to be copied. Sometimes, however, the arrangement may offer great difficulties, for instance, with a living object which has a will of its own and generally will offer some resistance, not to speak of the fact that it has to be placed in the most pleasing position according to its individuality; that it has to be properly lighted and must be brought in harmony with the surrounding objects, even if these should consist only of a few pieces of furniture. We must also take into account, that the optical apparatus must be in condition to take in the whole arrangement with the greatest possible sharpness and within as short a time of exposure as possible. The picturesque and the optical standpoint have both to be considered (very often the one or the other is overlooked).

The artistic standpoint will be fully considered in the æsthetical portion of this work; at present we will only take the mechanical arrangements into consideration.

When I focus a lens sharply on any object, say, for instance, a person, I will find that other objects, back or at the side of the sitter, appear also in the picture, materially influencing the beauty of the same.

These are either entirely left out by placing the object in front of a monotonous gray or more or less dark wall, which is called the background, or the accessories are so arranged that with the main object they form a harmonious picture.

The backgrounds are either made of cloth (the so-called "background cloth," which is expressly woven for this purpose), or they are painted on canvas or shirting with oil-paint, which is laid on as homogeneous and dull as possible. The background stuff is best placed on a frame analogous in its construction to the frames of the painters, which can be tightened by means of wedges, as circumstances may require.

The background may be hung on rails, *E*, *E*, and the upper part provided with rollers, *R*, *R*, as is represented in Fig. 15.

Such backgrounds are easily pushed aside provided the atelier is wide enough. The atelier must have as many rails as backgrounds, as every background has to run on its own rail.

Small ateliers require different arrangements. The background is placed on rollers and moved from place to place as required, or the background is not mounted at all, but rolled up like a curtain. All the backgrounds in Reutlinger's atelier are arranged as curtains. Six to eight such curtains, one behind the other, and parallel to each other, are placed at the spot where the sitter is placed. But the backgrounds suffer by being rolled and unrolled so frequently, particularly when they are painted with scenic or landscape effects. The wider the background the better it will be for the arrangement.

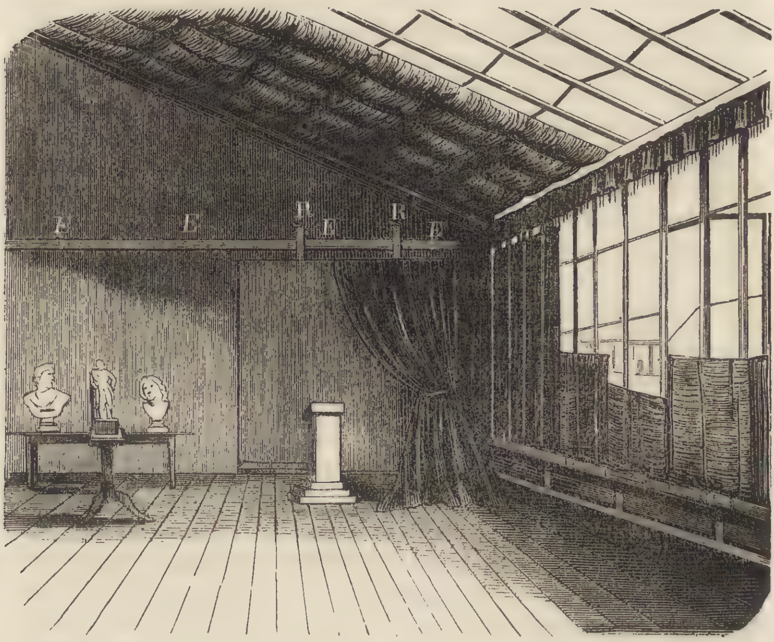
In regard to the employment of painted backgrounds full directions will be found in the æsthetical portion of this work.

For the suitable arrangement of the model other objects are necessary, according to the nature of the same, such as pillars, balustrades, furniture, curtains, &c. But most photographers do too much of a good thing. They have a complete furniture store in their ateliers. Eminent artists will get along with the simplest accessories. All such objects should be so arranged that they can be placed in position in the shortest time, and be removed again at a moment's notice without any noise or confusion.

Generally the sitters are in a hurry and wish to be taken in a short time, even if the time of the photographer should not be especially occupied.

With this simple arrangement, however, the original is not sufficiently prepared. An important point is that during the exposure perfect steadiness should be secured. With lifeless objects this is easily accomplished; they are placed on a solid foundation and fastened to it.

FIG. 15.

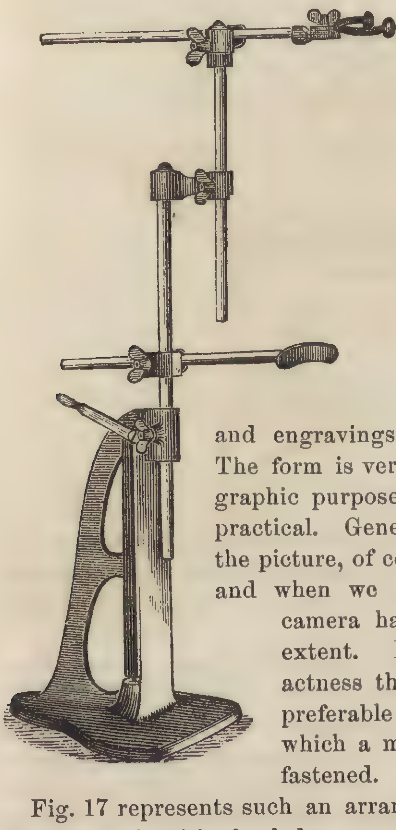


With a living model the case is entirely different. No one can sit absolutely still. Every pulsation causes an imperceptible motion, and just at the moment of exposure, when the model is conscious that on his steadiness success depends, the spirit is most willing, but the flesh is weakest, particularly the most important part of all the flesh,—the head. Nothing can prevent this evil but the use of the head-rest, against which the public obstinately protests, but upon the employment of which the photographer must just as obstinately insist. It should not be brought into use until all the other arrangements are finished, and everything is ready for the taking of the picture. Then the "rest" should be adapted to

the sitter, and not *vice versa.* The person who tries to force the sitter to the head-rest is guilty of "cruelty to animals," and is a sinner against good taste in the bargain. It is self-evident that this necessary evil must not be visible in the picture, a circumstance which often very sadly ties the hands of the photographer in making his arrangements.

Fig. 16 shows the construction of the head-rest generally used in the United States, and which is called "Wilson's Improved Rest."

Fig. 16.



For standing figures the rest requires great firmness, and the American pattern seems to be preferable, and all that is required. The joints should be frequently examined, and care should be taken that everything moves easy and without noise. Frequent cleaning and oiling is advisable. The American rests of less complicated and cheaper form are familiar to all, known as Scovill's, the Tuscan, &c.

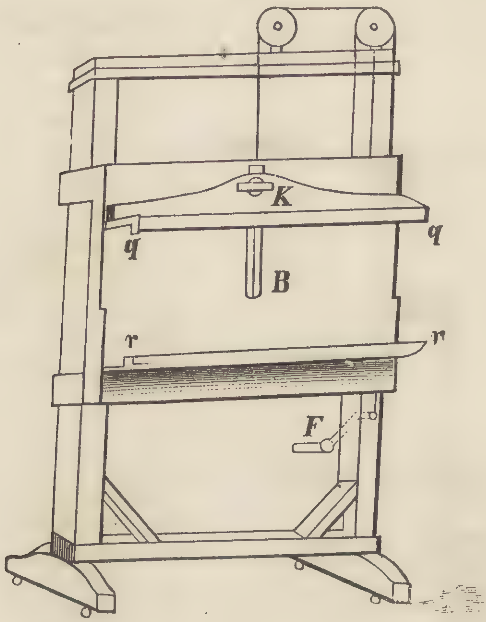
For the copying of paintings and engravings, an easel is generally used. The form is very well known. But for photographic purposes the easel would not be very practical. Generally they stand inclined, and the picture, of course, has the same inclination, and when we wish to avoid distortion, the camera has to be inclined to the same extent. For work requiring great exactness this is not sufficient, and it is preferable to employ a vertical stand on which a movable drawing-board can be fastened.

Fig. 17 represents such an arrangement. It consists mainly of the board, *B*, with the ledge, *r*, *r*, which serves as a rest for oil-paintings or drawing-boards. It can be moved in a vertical direction, and by the binding-screw, *K*, kept in position so that plates of different size can be firmly held. By a cord passing over rollers and worked by the handle, *F*, the whole is easily raised or lowered.

Drawings should be fastened to a drawing-board, which is placed on the ledge, *r*, *r*, and kept in place by the screw, *K*.

The whole apparatus is easily moved from place to place in the atelier wherever the illumination is the most favorable.

Fig. 17.



For copying plans, where absolute mathematical precision is required, the camera should be firmly connected with the stand which carries the original in such a manner that they cannot change their relative position to one another.

When the object has been duly prepared the arrangement of the optical apparatus is next in order.

Accordingly as we wish to get larger or smaller pictures of an object, the optical apparatus has to be removed or brought closer to the original, and therefore it should be easily removable. Hence the apparatus is generally placed on a stand. But as the different objects vary greatly in their height and breadth, the stand is supplied with a vertical and horizontal motion.

The construction of the stand is more or less massive according to the size and weight of the apparatus.

Fig. 18 and Fig. 19 show two of the forms most generally in use. Fig. 18 is better adapted for lighter cameras, while Fig. 19 (the

American Optical Company's "*Perfect*" camera-stand) answers for heavier ones. With the latter the vertical movement is accomplished by a handle and rack movement. The binding screw, is to keep the apparatus in any given position. The inclined position of the board is generally only employed in portraiture. It enables the operator to secure more nearly equal sharpness to the whole figure. The stands with rollers require a point which is driven in the floor to give them steadiness. In bringing the stand in position the beginner should take notice that in moving the bar in a vertical direction the picture on the ground-glass will move in the same direction.

Fig. 18.

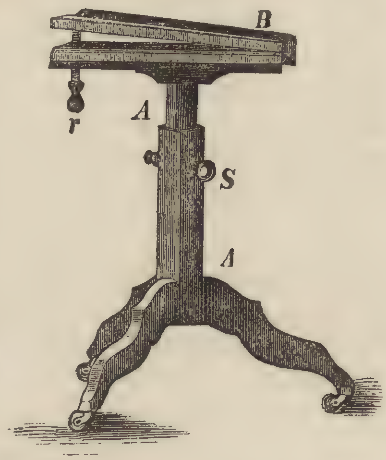
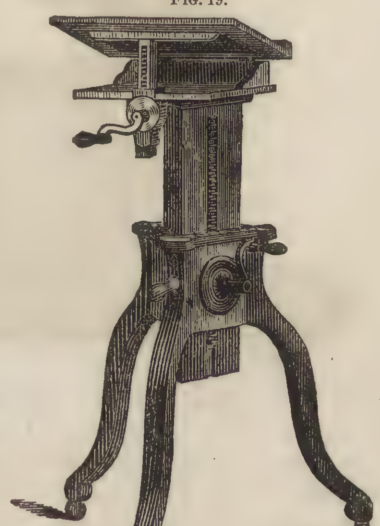


Fig. 19.



Iron stands have also been introduced; but generally these are too heavy and ruin the floor or the carpets. Arrangements have also been made by which the rollers can be fixed in position and give perfect stability to the apparatus.

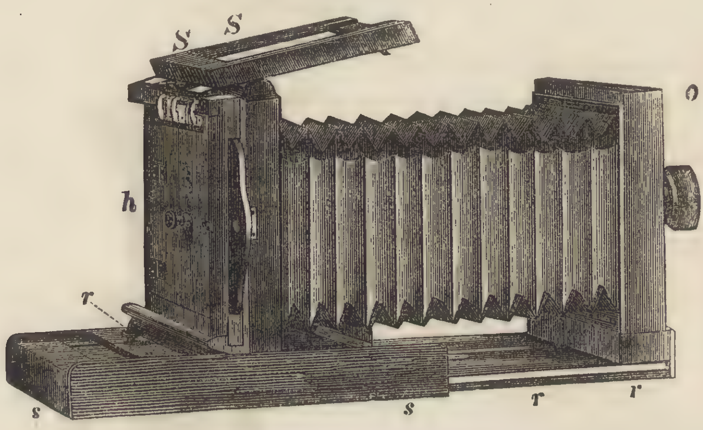
THE CAMERA.

The camera, in order to secure exact focussing, should be connected with the stand as closely as possible, so that the position will not change. A camera which is merely placed on the stand, is easily moved and often gives rise to faulty pictures. This is particularly the case with light instruments. Heavy ones will stand firm by their own weight.

The photographic camera is one of the simplest optical instruments. It consists of a box which is often formed of a pair of bellows only. The end, which is turned towards the object, is furnished with a lens called the objective, and the other end is provided with a plate of ground-glass, which latter can be moved nearer to or further from the objective. The box or the bellows serve to produce a dark space. It is necessary that this should be absolutely dark, a circumstance of which one must satisfy oneself in buying a new instrument by placing the head inside the camera, excluding all outside light by a cloth, and looking carefully for cracks which might admit the light.

To obtain a sharp picture the plate of ground-glass is brought more or less near to the objective. For this purpose the back part of the camera, *h*, can be provided with guides, *s*, *s*, which run in grooves parallel to each other. The screw, *r*, serves to fix the ground-glass at the desired distance from the objective.

FIG. 20.

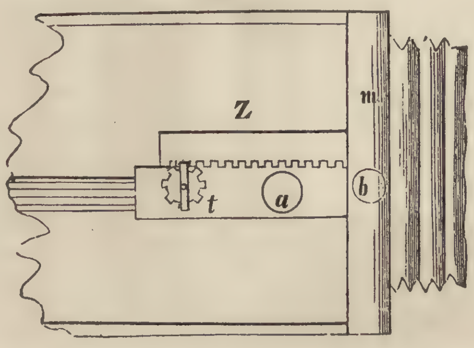


When the part, *h*, is brought very near to the objective, the projecting board, *s*, will prevent the operator from bringing his face very closely to the ground-glass, and make perfect focussing rather difficult. It is more convenient to pull out the front part, *r*, which moves in grooves inside of *s*, *s*. When the picture has been focussed tolerably sharp on the ground-glass, the finishing touches are given by either the rack movement on the lens itself, or by a rack movement at the rear end of the camera.

The screws *a* and *b* (Fig. 21) should be loosened; the back part, *m*, which carries the ground-glass, is now moved; *a* is screwed

tight, and with the rack movement, *Z* and *t*, the fine adjustment is made. Finally, the whole arrangement is fixed by tightening the screw *b*. In this way our German camera boxes are made.

Fig. 21.



The English cameras, to facilitate focussing, are provided with an endless screw, which moves the object-board *O* (Fig. 20). The screw is worked by a crank. This arrangement is very handy, but admits only of limited motion.

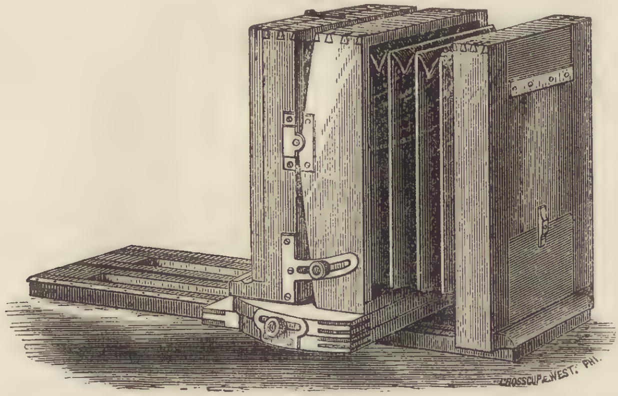
A better arrangement than any of these is applied to the boxes made in New York by the American Optical Company. The front part of the frame of the camera box is made fast to the platform, and the focussing is done with the back part of the frame, which runs on metal guides attached to the sides of the platform. An approximate focus is thus obtained, and the exact focus is secured by means of a short focussing screw which works in a groove in the centre of the platform. A clamping screw fastens the whole rigidly in place when the focus is obtained. This arrangement may be seen in Fig. 23*a*.

When the focussing has been accomplished, the ground-glass, *S*, *S* (Fig. 20), is turned back and in its place the plate-holder is pushed, carrying the sensitized plate. The sensitive plate must occupy exactly the same position which the ground-glass has occupied before, or the picture will lack sharpness.

To find out if a camera works correctly in this respect, the lens is removed and through the hole a rule is introduced. The distance between the ground-glass and the front of the camera is noted down; next a plate-holder with a plate of glass is put in position; the shutter is opened and the distance between the glass and the front of the camera is noted down. When the two exactly correspond the plate-holder is correct. Sometimes the ground-glass

admits of slight movement by means of the so-called double swing-back. This motion is of advantage for the sharp focussing of

FIG. 21*a*.



such objects which have an inclined position to the axis of the instrument.

The swing-back is a great help in focussing accurately and in getting the correct figure on the plate without trouble, and is applied to the American Optical Company's boxes. Very often the figure is too high or too low upon the plate. A vertical motion of the back of the camera, one way or the other, will obviate this at once. So when more or less of one side or the other is needed in the picture a lateral motion or swing at once secures it. The back is then secured in place by the clamps and screws as shown in Figs. 21*a* and 23*a*.

The construction of the plate-holder is easily understood from the cut (Fig. 22). The sensitive plate is placed in the frame, *B*, and rests on the silver wires, *d*, *d*. The lid, *D*, is now closed and the spring, *f*, presses firmly on the plate and keeps it in position. The shutter, *H*, remains closed and is only opened when the plate-holder has been placed in the camera and everything is ready for the exposure.

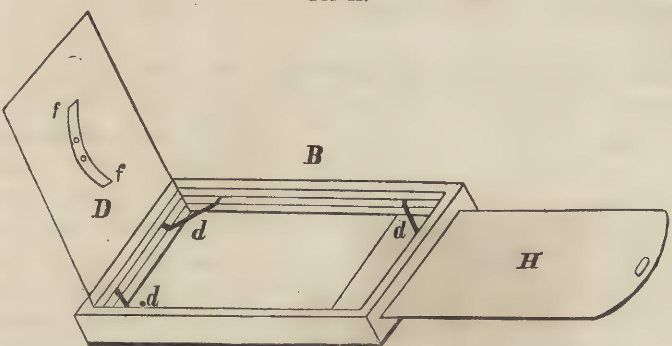
The wood of the holder is apt to become warped, being frequently moistened by the drippings of silver solution from the plate. The wood should be well oiled and varnished, and the different pieces should be joined crossways, one upon the other, and all the different parts well dovetailed together.

In Europe the shutters of large plate-holders are frequently provided with hinges, which admit of their being bent over; the

American plan, where the shutter can be removed entirely, is preferable.

In the bottom of the holder a little cavity is placed, made water-tight with pitch, to collect the silver drippings. Such a holder,

FIG. 22.



unless it is carefully wiped every time it has been used, is liable to get spoiled by the silver solution entering the wood. The solution decomposes in the wood, and the products of decomposition are by capillary attraction carried to the collodion film where they cause moss-like spots. The author, to avoid this, places the lower part of the plate-holder for five minutes in melted parafine. This preserves them for years. It has also been recommended to paint the corners with negative varnish. Such a paint, however, would have to be repeated monthly.

FIG. 22*a*.

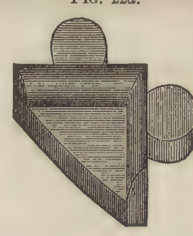
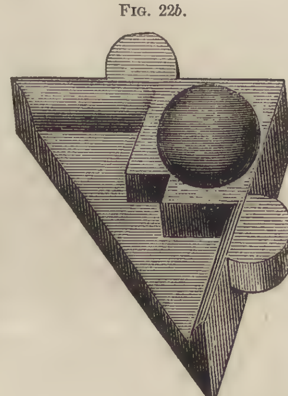


FIG. 22*b*.



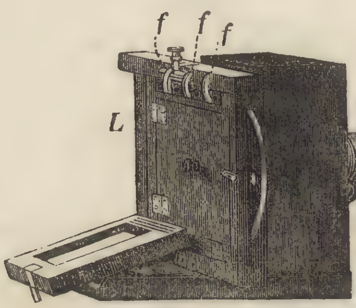
The sizes of the holders vary considerably. In order to place plates of different sizes in the holder, they are furnished with inserting frames or "kits," which are provided with silver wire corners on which the plates rest.

I must again express my preference for the American boxes. The holders in them are supplied with improved glass corners, which are impervious

to all action of the solution. Moreover, they are made of such a shape (see Figs. 22*a* and 22*b*) that they bind the wood frames together so that it is impossible for the solution to get to the wood at all. Another advantage is the *reversible* corner (Fig. 22*b*), which is familiar to all my American readers and need not be described here. These corners are far preferable to the silver wires.

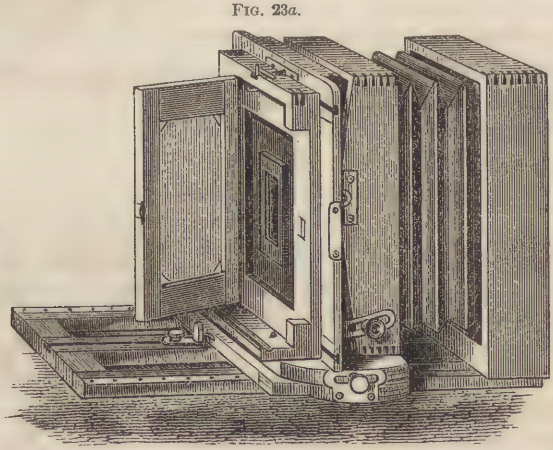
Then there are the sliding holders, by which two, three, or more pictures can be taken on the same plate. On a broad board, *L*, *L* (Fig. 23), the holder moves in a groove in a horizontal direction. Three points, *f*, *f*, *f*, which catch with springs in notches, serve to keep the plate in a fixed position. The so-called "carte de visite camera" is so constructed.

FIG. 23.



For beginners it may be necessary to call attention to the fact that the camera must not be moved while the ground-glass is removed, and the plate-holder put in its place. And that the shutter, *H*, must not be pulled until the holder is in its place. When all this has been done

FIG. 23*a*.



the cover is removed from the object-glass, but without shaking the camera.

Alluding to the American boxes again, Fig. 23*a* represents

another kind of sliding box, and is known on the American Optical Company's catalogue as the "Imperial" box. In it the frame holding the plate-holder is made to slide laterally on a platform, which platform again may be moved vertically, proper catches being furnished to fasten both in position. In this way the plate is moved over the field of the lens, allowing the operator to take several positions on one plate and even to change the sizes. Internal diaphragms are supplied to effect the changes in size.

USE AND CONSTRUCTION OF THE CAMERA-TUBE.

The objective consists of a tube containing either single or compound lenses and stops. The size of the tube depends on the size of the lenses, the distance which they require to be apart, and the position of the stops.

Fig. 24 shows a very general mode of mounting. It represents a Busch portrait objective with separate central stops, *D*, *D*, which are placed in the slit at *X;* the flange, *R*, is screwed to the front of the camera-box. The back lens is at *H*, and the front lens at *r*. With the cap, *C*, the lens is covered or uncovered. By the rack and pinion movement, *T*, the fine adjustment in focussing is made. The front piece, which is screwed on at *r*, serves not only for carrying the cover, but excludes also side-light. The fault of this construction is the *detached stops*, which easily get lost.

FIG. 24.

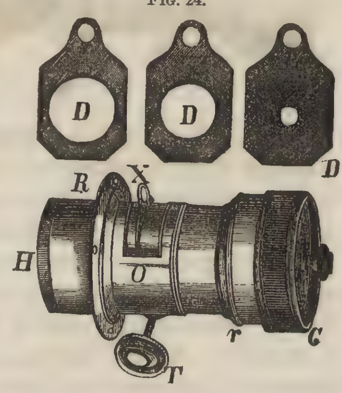
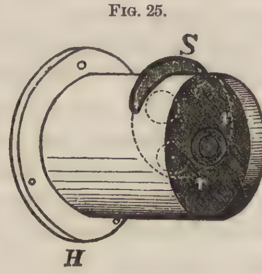


Fig. 25 represents a landscape tube, by Ross, without cover. The simple lens is placed at *H;* the stops are permanently fixed and consist of a disk, *S*, with different sized apertures. By turning the same, the dimensions of the stop are easily changed; a black disk, *r*, with an opening equal to the size of the largest stop, closes the tube in front.

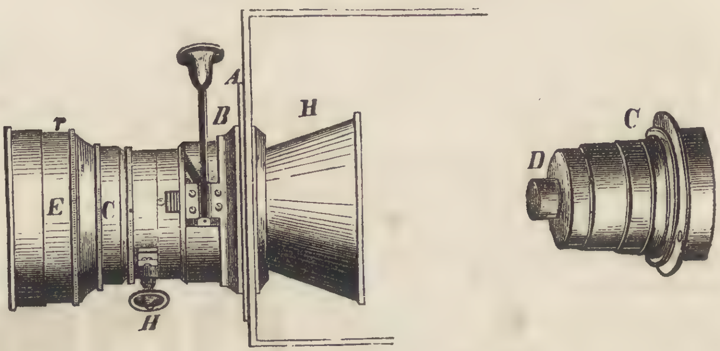
FIG. 25.



There are other tubes in the market, where the front lens can be used as a landscape lens. To this class belong the "cone" objectives, as shown in Fig. 26.

The back lens, *H*, is as large as the front lens. This lens has a movable mounting, and can either be entirely drawn out or brought more or less closely to the other lenses, to lengthen and shorten the focus. The stops consist of rings, which are placed inside the tube at *D*, the front part, *C*, having been previously removed. This front part, by being screwed in a reversed position to the mounting, forms, when all the other parts are removed, a landscape lens at *D* (see Fig. 26), with stops and cover.

FIG. 26.



The inside of the tubes should be perfectly black. When these surfaces reflect light, we will have spots on the plate at once. The tubes are generally screwed to separate boards or fronts, which are easily detached from or placed on the camera.

For the purpose of exact adjustment of focus, the stop with the largest opening is generally used. Only a part of the picture becomes sharp, and to remedy this, stops with smaller openings are introduced after the focussing has been done. When we wish to extend the sharpness as far as possible to the margin of the plate, we use a very small stop. To see the image on the ground-glass more distinctly, a cloth, which is thrown over the head, is of advantage. A focussing-glass enables the operator to focus with much more certainty. To what degree of fineness the ground-glass has been ground is of much importance, for all imperfectly ground glass is frequently a source of error. Focussing is much easier with an objective giving fine illumination and in clear weather. In cloudy weather, and with lenses that do not have much light, it is sometimes rather difficult.

A precautionary measure, which, particularly in bright weather, should be observed, is the exclusion of all extraneous light from the objective. Every objective acts not only as a lens, but also as

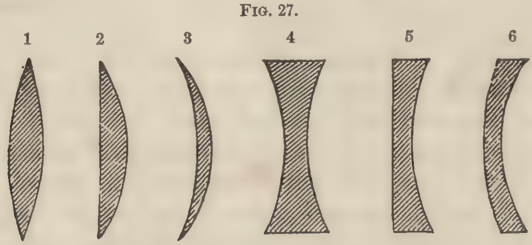
a window, and admits a great deal of diffused light, and this causes either fogging of the whole plate or interferes with the brilliancy of the picture. This diffused light is easily discovered by placing the head under the focussing-cloth, the ground-glass having previously been removed. The camera, with lenses of large opening, will appear very light. To exclude this foreign light a box is used which surrounds the objective, and has only an opening in front, which can be opened and closed by a lid.

Claudet and Bingham place the whole apparatus in a kind of tent which moves on rollers. The arrangement appears very clumsy.

DESCRIPTION OF PHOTOGRAPHIC OBJECTIVES (TUBES) AND LENSES.

The form of lenses which are used in the optical department of photography will be explained by the following figures.

FIG. 27.



Numbers 1, 2, and 3, are thicker in the centre than on the margin. They are called convex lenses. Numbers 4, 5, and 6, are thinner in the centre than on the margin, and are called concave or dispersing lenses. We distinguish biconvex (No. 1), plano-convex (No. 2), concavo-convex (No. 3), also biconcave (No. 4), plano-concave (No. 5), and concavo-convex (No. 6). The connecting lines of the centres of the spherical surfaces, which form the surfaces of the lenses, are the axis of the lens. Any plane which is placed through the axis of the lens, is called a main section.

The collecting lenses have, within certain limits, the faculty of collecting to a point the rays, which proceed from a point, provided that these points are situated on the axis or near it, and provided that the angle which the rays form with the axis is not too large. When, under these conditions, a bundle of rays, parallel to the axis of the lens, falls on a lens, the rays will be united in a point back of the lens, and this point is called the focus, and the distance between the focus and the lens is called the focal distance. The

rays, which proceed from a point on the axis or near to it, are also united in a point back of the lens, and it is easy to calculate its distance from the lens. If, for instance, the focus is $= P$, the distance of the point of light $= a$, and the distance of its image $= x$, it follows that—

$$\frac{1}{x} = \frac{1}{P} - \frac{1}{a}$$

$$X = \frac{ap}{a-P}$$

For instance, a lens has a focal length of 10 inches and is 120 inches distant from an object, then—

$$a = 120 \text{ inches, } P = 10 \text{ inches;}$$

hence—

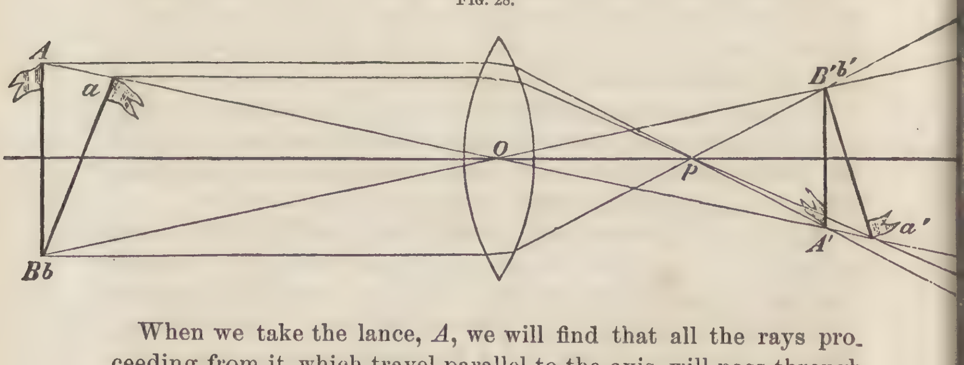
$$\frac{ap}{a-P} = \frac{120 \times 10}{120 - 10} = \frac{1200}{110} = 10.9 \text{ inches;}$$

hence x is, *i. e.*, the distance of the image from the lens $= 10.9$ inches. When the distance, a, is greater than 100 times the focal length, the image and the focus will nearly coincide.

When we direct a lens to very distant objects, we will get in the focus of the lens a small reversed image of the object.

When the object is brought nearer to the lens, the image will appear further removed from the lens. The exact spot is easily found by construction and calculation.

Fig. 28.



When we take the lance, A, we will find that all the rays proceeding from it. which travel parallel to the axis, will pass through the point, P. The rays which pass through the optical centre, O, of the lens do not change their course. The point where the rays proceeding from a or b cross each other determines the location

of the image a', b'. When lens and object are parallel to one another, the image will also be parallel. When the object is inclined to the lens, the image will also be inclined, but in a reversed position.

These circumstances must be well observed in focussing with the camera obscura. The lines a, o, and b, o, which pass through the optical centre of the lens are called side axes in regard to the points a and b. All objects, the distance of which is more than a hundred-fold the length of the focus, will form their image in the focus of the lens. When we move the lens closer to the object, the image will move out of the focus, and when we move the lens still closer, and to within twice the length of the focus, the image will also be removed twice the length of the focus from the lens or object, and the image will be equidistant from the lens in opposite directions. When we go still closer, the image will remove still further from the lens, or more than twice the focal distance, and more than the distance of the object itself. The size of the picture depends on its distance from the lens. When the same is $= x$ the distance of the object $= a$ its size $= G$ then the size of the picture will be

$$= \quad \frac{x}{a} \quad G \quad \frac{P}{a - P} \quad G.$$

Hence the image will become larger as we approach closer to the object. Hence, also, we can make larger or smaller pictures of the same object by bringing the optical apparatus closer to, or by removing it further from, the same.

When the object is removed further than twice the focal length of the lens, its image will be less than the "natural size." When the distance of both is equal, or the object is twice as far removed from the ground-glass as the focal length, then the image will be of equal size with the object. *This fact is important in copying when a copy is to be made of the same size as the original.* The camera has to be drawn out to equal the distance of the object. When the object is moved still closer, we will get magnified pictures.

We can, therefore, with any lens, make larger or smaller pictures of the same object, and it would appear as if we could with a lens take pictures of any size to suit our pleasure. This, however, is not the case, as a lens, *similar to our eye*, can only take in a limited field of view at one time.

When we close one eye we overlook with the other a field of 90° circumference of angle, but we must turn the eye a little. So, also, every lens takes in a limited field only, which is called its

field of view. When we move a photographic apparatus far away from the model, the whole figure, of a person, for instance, will appear in the picture. When the apparatus is moved closer, the proportions become larger; we no longer see the whole figure, but only three-fourths of it; and when we go still nearer, the head and chest only will appear.

Large objects, when they are wanted entire in the picture, should be far removed from the camera. But of such objects only small pictures can be made.

With the increase in the length of the focus, the distance of the object from the lens remaining the same, the size of the picture will increase, and hence we select for large pictures lenses of long focus. When a is the distance of the object, G its size, p the length of focus, x the distance of the picture, then the size of the picture is B—

$$B = G \frac{p}{a-p}$$

When the distance is very great, then—

$$B = G \frac{p}{a}$$

i. e., the sizes of the pictures are proportioned as the focal lengths.

A lens of 7 inches focus is placed opposite to a person 5 feet high at a distance of 8 feet, then the size of the picture—

$$B = \frac{5 \text{ feet} \times 7 \text{ inches}}{8 \text{ feet}} = \frac{60 \text{ inches} \times 7 \text{ inches}}{96 \text{ inches}} = 4\tfrac{3}{8} \text{ inches.}$$

The field of view of a long focus lens is, when the proportions of the radii are equal, no larger than that of a short focus lens.

The production of pictures by a lens proceeds only under certain conditions in a regular way, which conditions have already been indicated above, and which become still more easily understood by the mathematical development which is given with it.

1. That the rays strike near the axis.
2. That they form only a small angle with the axis.
3. That they are monochromatic, or that they all possess the same index of refraction.

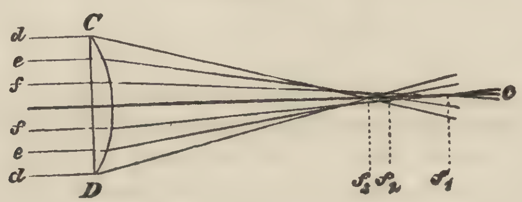
These conditions can easily be maintained in telescopic or microscopic lenses, but it is much more difficult with a photographic lens. In the latter the rays form very often a considerable angle, sometimes as large as 45°, and this gives rise to a whole line of errors, which only partially can be overcome by optical means. To these errors belong—

1. SPHERICAL ABERRATION.

When a single lens (a so-called landscape lens) is attached to a camera, and when we remove all the stops, we cannot obtain on the ground-glass a picture which can be called absolutely sharp, for such will always show blurred and ill-defined outlines. The picture, however, will become instantly sharp when we cover the front of a lens with a disk in the centre of which a hole has been cut, or in other words, a stop. The cause of this want of sharpness is the unequal refraction of the marginal rays as compared with those of the centre. The margin of the lens is, so to speak, a prism with a much stronger refracting angle than the centre. As the dispersion which the rays suffer increases with the refracting angle of the prism, it follows that the marginal rays will intersect the axis nearer to the lens than the central rays.

The focus of the marginal rays will, for instance, be in f^3, while the focus of the central rays will be in f^1 (Fig. 29).

FIG. 29.



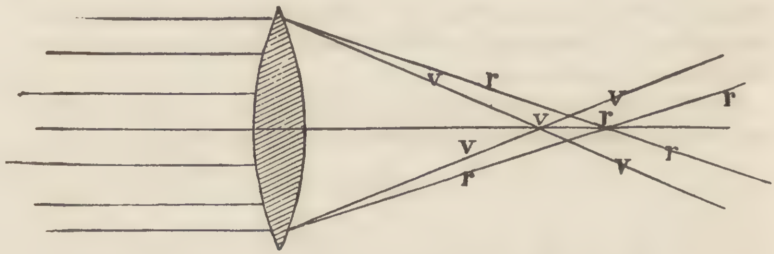
Hence, if the ground-glass has been placed at f^1, the marginal rays, which have intersected the axis at f^3, will form a circle of dispersion. The diameter of this circle is called the transversal or lateral aberration. It is easily understood that this must be different in two lenses of *equal opening* and *different focal length*, and it must be the larger, the shorter (with the same opening) the focal length is. And it is also easily understood that with two lenses of *equal* focal length and *different* opening, the transverse aberration will be largest with the largest opening.

2. CHROMATIC ABERRATION OR DISPERSION OF COLOR.

The white light suffers in its passage through refracting mediums, not only by the refraction, but also by the dispersion of color, the cause of which is that the apparently monochromatic white light consists of rays of different quality, which partly distinguish themselves by their different effects on the retina and chemicals, and

partly by their different refractions. Red has the least refraction; violet the greatest. The dispersion of color is most beautiful in the passage of white light through a prism, and then it gives rise to a colored band—*the spectrum*—in which the seven principal colors, violet, indigo, blue, green, yellow, orange, red, are distinguished. As a lens, however, is analogous to a system of prisms, such a dispersion of color must necessarily also take place in the passage of white light through a lens, and as violet light is more refrangible than red, it follows that the violet rays will intersect the axis closer to the lens (after having passed through it) than the red.

FIG. 30.



Hence, when a bundle of parallel rays of white light passes through a lens, the rays will not, after having been refracted, be united in a single point, but will, according to their different refrangibility, be placed at different distances from the lens on the axis of the same. The violet ones being the nearest to the lens, the red ones the farthest, and instead of having a single point, the focus, which would result with the employment of a monochromatic light, we will have a line of differently colored foci. (See Fig. 30.)

This error is overcome by the employment of two lenses, which are made of different kinds of glass (crown and flint). Nearly every photographic lens is made of these two kinds of glass; but even with one kind of glass, by suitably selected forms of lenses, the chromatic aberration can be tolerably well avoided, as is the case with the Zentmayer lens.

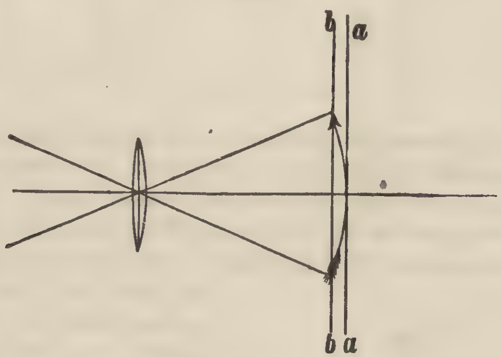
CURVE OF THE SURFACE OF THE PICTURE.

When a camera with any kind of an aplanatic lens is sharply focussed on an object, it will be noticed that it is not possible to get all the different parts of the picture sharply defined on the ground-glass at the same time. It is either sharp at the margin and poorly defined in the centre, or *vice versa*. This error is not

caused by spherical aberration, for it occurs with all perfectly aplanatic lenses—that is, lenses which have been corrected for spherical aberration; but the cause of it is the curve of the image.

The picture does not lie on a plane like the ground-glass, but on a more or less curved surface, and by moving the ground-glass, only that part of the picture will appear sharp which touches or intersects the ground-glass. The arrow in Fig. 31 represents such a picture. When the ground-glass is placed at *a*, *a*, only the central part will appear sharp. When we place the ground-glass at *b*, *b*, only the points of the arrow will appear well defined.

FIG. 31.



These errors are avoided by suitable curves in the lenses, by combinations of lenses, and by stops.

DISTORTION.

When we focus, with a single lens with front stops, sharply on a square, *A*, the resulting picture will not appear as a square, but with curved sides, almost as a barrel, *B*. The lines are curved outwards. When we substitute a lens with the stop in the rear, the curves will be reversed, as in *C*.

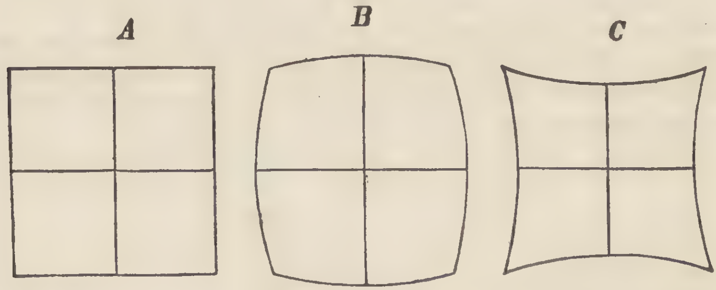
This is the case with all single lenses, but not always to the same extent. It is based on the fact that the marginal rays of the field of view strike the lens under a larger angle than the central rays, and consequently suffer a greater refraction.

But in this refraction, according to the position of the stops, the marginal rays are either brought nearer to the centre of the field of view, as is the case with a front stop, or they are removed from it, as is the case when the stop is placed behind the lens.

This distortion becomes more prominent with the increase in the

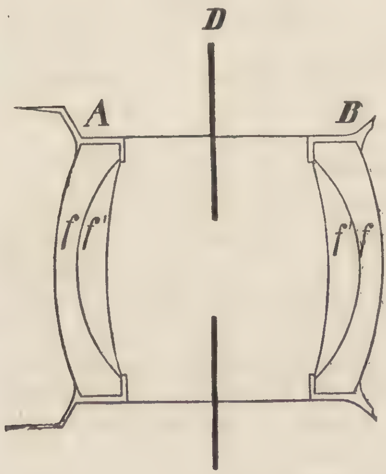
size of the field of view. It is particularly annoying in copying drawings, or taking architectural views. When single lenses are used for this purpose, the central part only can be employed. The distortion is dependent on the form of the lens. Amongst all the

FIG. 32.



simple forms of lenses, the meniscus lens, when its concave side is turned towards the object, shows it the least. It increases rapidly with a plano-convex lens, the plane side turned towards the object, and still more so with a biconvex lens. With single lenses the distortion can be reduced to a minimum by giving the proper form to the glass, but it never can be avoided entirely. This is only possible by a combination of lenses with so-called central stops. Imagine two lenses, *A*, *B*, at a certain distance from one another, and between the two, in the centre, the stop, *D*. In regard to the front lens this arrangement will act like a back-stop, and will cause the distortion noticed at *C* (Fig. 32), while, with regard to the second lens, it will act like a front-stop, and cause distortion similar to *B*. But as both distortions are in opposite directions, they will balance each other, and the result will be a correct image like *A*.

FIG. 33.



Such double objectives with central stops are the Globe, Zentmayer, Ross Doublet, and the new Aplanatic lenses by Steinheil.

The portrait tubes of Petzval are similarly constructed, but as the lenses are very unequal, a considerable distortion remains.

FIELD OF VIEW AND AMOUNT OF LIGHT OF A LENS.

By the term, that a lens is strong in light, we mean its capability of giving a more or less bright picture. This depends—1, on the surface of the lens; 2, on its focal length; 3, on the loss by reflection and absorption which light suffers in its transit through the body of the glass.

The larger the surface of a lens the greater will be the quantity of light which it is capable of receiving. However, the surface contents are proportioned to the square of the diameter, or, as it is generally called, the opening. Hence, the amount of light of two lenses will be proportioned, other things being equal, as the squares of their openings.

When the focal distances of the lenses are different, they will give of the same subject pictures of different size. When, for instance, a lens of 6 inches focus gives of a man a picture of 3 inches, then a lens of 12 inches focus will represent a man as 6 inches high in the picture. The quantity of light which proceeds from the subject and falls on the lenses is necessarily the same, provided the openings are equal. But with increased size of the picture the quantity of light is spread over a larger surface. When the same quantity of light is distributed over a surface of two or four square inches, then the quantity of light on a square inch of the latter surface will only be half as great as on the former.

But the surface contents of two similar figures are proportioned as the squares of similar located lines—for instance, as the squares of their heights. But as the size of a figure in the picture is proportioned to the focal length of a lens, it follows that the surface contents of the same are as the squares of the foci, and as the amount of light is just the reverse of their surface contents, it follows further: *The amount of light of two lenses is proportioned as the inverse ratio of the squares of their foci.* Opening and focus are, hence, the main elements for judging the amount of light which a lens has. The direct proportions of the former, the indirect proportions of the latter form the criterion.

When we wish to compare two lenses in this respect, we have to divide first the opening, o, by the focus, f, and find the square of the fraction.

The fraction $\frac{o}{f}$ is called the relative opening. Of the import-

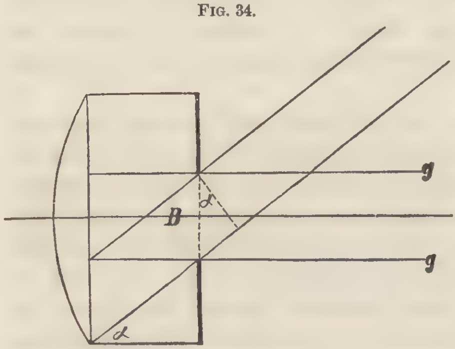
ance of the same we shall have something more to say in a future chapter on testing the objective.

This calculation holds good only for lenses with full opening. When, however, lenses are used that have stops, the size of the stop has to be substituted for the opening of the lens, and we can only compare front-stop with front-stop, and back-stop with back-stop.

The brightness of a picture, however, is not equal in all its parts. The eye alone tells us that the brightness of the image decreases from the centre towards the margin.

This circumstance is easily explained. Let us consider the simple case of a lens with a front stop. The diameter of the rays, g, g, which pass through the lens parallel to its axis, is of the same size as the opening of the stop B. The diameter of the oblique bundle of rays is equal to the diameter of the stop multiplied with the cosinus of the angle of incidence, or equal to B cos. x, or, for instance, for an angle of $60° = \frac{1}{2} B$, and as the brightness is proportioned as the square of the opening, the brightness of centre and margin will be proportioned as 1 to 4.

FIG. 34.



With increased obliquity of the rays towards the lens the brightness of the margin of the picture will correspondingly decrease, and this is the reason why it becomes so prominent in wide-angled lenses.

To this must be added, that rays falling obliquely on a lens lose a considerable amount of light by reflection from the surface of the glass, and that this loss of light increases with the increase of obliqueness.

This causes, in short exposures, the apparent under-exposure of the margin. Sometimes this is of advantage, when it is desirable to concentrate the main light on a characteristic object located in the centre of the plate, as, for instance, on the head in portraiture. It becomes very annoying in pictures of buildings, landscapes, and drawings, however.

The above-mentioned reflections from the surface of the glass manifest themselves otherwise unpleasantly as they produce the so-called light spot (ghost) and secondary pictures.

When light falls on a lens, a part of it is reflected from the surface, another part enters the lens, passes through it, and on the back surface another reflection takes place. The reflected rays strike the front surface, are again thrown back, and are now by the back surface partly reflected, partly refracted, and thus a secondary picture is formed, which of course is very feeble and of little effect in short exposure, but which will make itself felt and seen with a long one. The focus of the secondary picture is dependent on the curve of the lens. Generally it is quite different from the principal focus of the lens, and the consequence is that the secondary picture does not appear sharp on the ground-glass when the lens is in focus, but only as a bright spot next to the bright object. With an increased curve of the surface of the lens the reflection will increase, and also the brightness of the secondary picture. By reducing the size of the stop, the sharpness of the secondary image increases (particularly in such lenses as the Globe lens), and when the front lens is struck by direct sunlight, or is turned to the bright blue sky.

When the focus of the secondary picture is infinite, then it will appear as an image of the stop, and will be distinctly noticeable as a bright spot in the centre of the picture. When, in such a case, we move the stop forward, the spot will become smaller and better defined, and the reverse takes place when we remove the stop backwards. The latter proceeding enables us sometimes to avoid or to reduce its evil effects.

We have still to explain what we mean by the expression, the field of view of a lens.

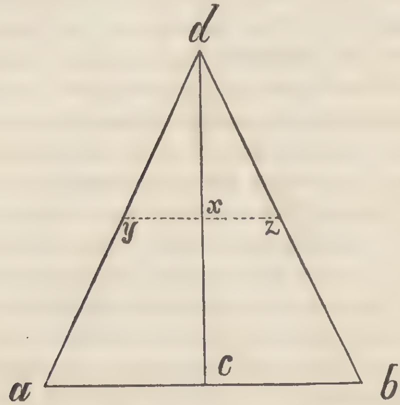
When a lens is screwed to a large camera and focussed on a distant object, we will notice on the ground-glass a bright circular disk. The diameter of the disk is independent of the size of the stop. When we compare lenses of unequal construction and equal focus, we will find that this similar image is of very different size. The angle, under which this picture is seen from the optical centre of the objective, is called the field of view of the lens.

When $a\ b$ is the diameter of the round picture, and $c\ d$ equal to the focal length, then is the angle, a, d, b, the field of view.

Of the round picture only a portion will appear sharp—namely, the central part, and the sharpness will extend further towards the margin as the size of the stops decreases.

The practical size of the picture is, hence, for a given stop, always smaller than the field of view. This size, as well as the size

FIG. 35.



of the field of view, is also determined by the angle, *d*, formed by lines drawn to two diametrically opposite points of sufficient distinctness.

DESCRIPTION OF PHOTOGRAPHIC OBJECTIVES.

We have explained in the previous chapter the shortcomings of our lenses. We have demonstrated that these shortcomings, in the face of the exacting demands which are made upon a photographic lens, can only partially be overcome, and not entirely removed, and all our photographic lenses, even those of the very best construction, will leave something to be desired.

The qualities expected in a photographic lens are, 1. A great amount of light, to enable us to take, in the shortest space of time, the picture of a dark or a moving object. This can only be accomplished by a large opening and short focus. 2. Great sharpness even to the margin, a quality that can only be secured by the employment of small stops, and just the opposite condition to what is required in the first case. 3. A large and plain field of view. This requires very oblique rays of light, for which the spherical aberration and the curvature of the picture can only be corrected with great difficulty. 4. Freedom from distortion. 5. Absence of chemical focus. 6. Equal intensity of light over the whole field of view. 7. Depth, or equal sharpness for objects which are at unequal distances from the camera.

All these conditions can only be fulfilled with difficulty and not

at the same time, and this is the reason why we have no universal lens answering all purposes. For this reason also, we are compelled to employ different lenses for different work.

Most lenses conform, in a degree sufficient for practical purposes, to the condition mentioned under Class 5, but only partially to the other conditions.

The portrait objective fulfils condition No. 1, a large amount of light, but the others only imperfectly. The triplet objective and the Steinheil aplanatic lens fulfil condition No. 4 (correct drawing); they excel the portrait lens in regard to condition No. 3, the field of view, and No. 7, but are inferior in regard to the amount of light. The pantoscope and the Zentmayer lens excel all others in field of view and depth (No. 7); are the equals of the previous ones in regard to No. 4 (correctness), but inferior in the amount of light. The Dallmeyer landscape lens answers the same conditions as the Steinheil lens, but is inferior to it in correctness of drawing and the amount of light. The Ross doublet fulfils the conditions similar to the latter, and are correct in drawing. Depth is only found in instruments with a small opening. The most perfect is the pantoscope, and the least so is the portrait lens. It is not to be wondered that we find so many different constructions which perform so well in one direction and do so little in another.

To describe all these constructions would be out of place in a work of this kind. We will only refer to those which we consider the most important and which we have tried practically. The manner of testing lenses we will explain further on.

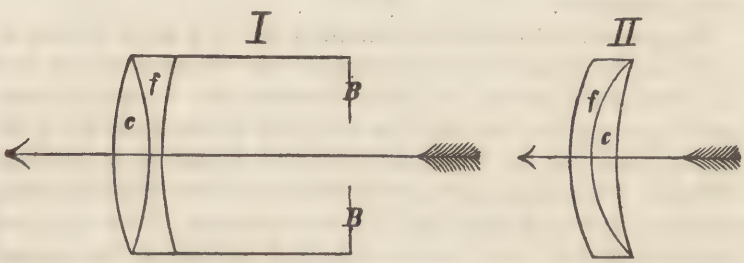
1. THE SIMPLE ACHROMATIC OBJECTIVE, OR THE SO-CALLED LANDSCAPE LENS.

This simple objective is the oldest photographic lens in existence. Its forms are very different, but are always an achromatic combination, consisting of a pair of lenses cemented together, and with a front-stop. Skilled photographers very often remove single lenses from a system, and use them with proper front stops for landscape work, where a little distortion is of trifling importance. The almost plano-convex front lens of a portrait combination is very often used for this purpose by reversing it and placing stops in front. For many purposes this is sufficient. There are many photographers who make reproductions with such a lens. The distortion becomes only perceptible when the field of view is taken too large. Within an angle of 15° it will hardly be noticed.

The lenses which were first introduced in the market under the name of landscape lenses had the following form:

Fig. *I*, *f* represents flint-glass; *c*, crown-glass. The stop, *B*, *B*, is generally one-fifth of the focal length distant from the lens.

Fig. 36.



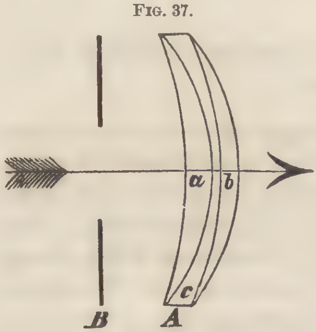
We meet with this lens in many ateliers. Besides this form there are many others which, in regard to field of view, size of picture, and correctness of drawing, yield better results.

One of these is in the form of a meniscus, *II*, consisting of a concavo-convex crown-glass and a convex-concavo flint-glass lens; both are cemented together with Canada balsam similar to the old lenses.

A third form, which gives still better results, is Dallmeyer's landscape lens.

This combination consists of three lenses cemented together. The central one is made of flint-glass, and the two outer ones of two different kinds of crown-glass. The stop is placed at about one-tenth of the focal length from the lens. Instead of several stops, which can be changed according to the wish to increase the sharpness towards the margin of the field, the Dallmeyer lens is provided with a circular disk with different sized holes; the disk is fastened to the tube.

Fig. 37.



The distortion of this lens is less than any of the other forms, also the curve of the picture; both are favorable to the size of the field of view, and give the further advantage that with rather large stops sufficiently sharp pictures can be obtained. The opening of the smallest stop is one-thirtieth of the focal length.

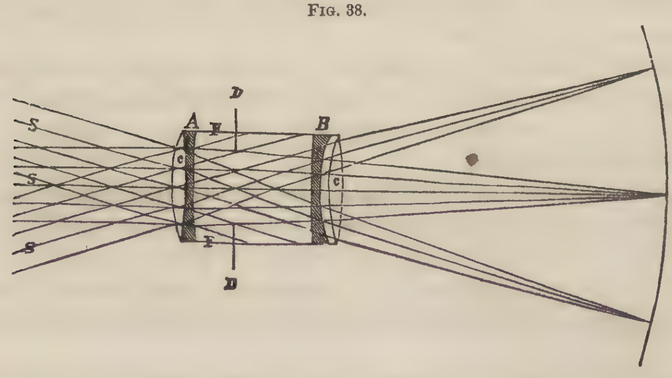
2. THE PORTRAIT OBJECTIVE.

The Landscape objective was, in the earlier days of photography, almost exclusively employed. It suffices for landscapes, where the objects are at rest, where light is at one's disposal, and where a little distortion does not amount to much. For this class of work the landscape lens is employed to this day. The opening of such a lens, however, is small, under the most favorable circumstances one-twentieth of the focal length, and the consequence is a proportionably small intensity of light, which becomes particularly annoying when we wish to take interiors, rooms which are only partially illuminated. A person in the glass-house had to sit in front of such a lens for several minutes, and this circumstance compelled the early photographers to place their models often in the open air, and even in direct sunlight. That in this way no artistically perfect pictures could be made is self-evident, and it became soon necessary for portrait photographers to have a lens that would work with a large opening, and hence have a large amount of light.

The invention of such a lens by Petzval, in Vienna, in the year 1841, was an event in photography, as by it portraiture became a possibility.

The invention of these lenses is no accident, but the consequence of a thorough theoretical calculation. Voigtlander, in

FIG. 38.



Vienna, made the first lens according to Petzval's directions, and Martin, in Vienna, took the first daguerreotype with short exposure.

This Portrait lens is a double objective with central stop and two unequal lenses.

The front lens, *A*, consists of a biconvex crown, and an almost plano-convex flint-glass lens, which are cemented together with Canada balsam.

The back lens, *B*, consists of a plano-meniscus of flint, f', and a biconvex crown-glass lens, c', which are separated by a ring.

Between the two the central stop, *D*, is placed, which has to be smaller in proportion as we wish to push the sharpness of the picture to the margin. In this general form, all the portrait lenses coincide; only the new Dallmeyer portrait lens differs from it by the reversed position of the back lens. Otherwise we find variations with different opticians in regard to focal length of the separate objectives, *A* and *B*, the distance and size of the same, the position of the stops, &c., which materially influence the qualities of the lens.

A comprehensive exhibit of these differences the table on page 67 is intended to furnish, which contains the result of the measurements which have been made in the celebrated optical establishment of Herr E. Busch, in Rathenow, with different portrait objectives of 36 lines diameter:

The effect of the two combined glasses is given in a great measure in the explanation in the previous chapter on the errors of lenses.

The front lens is almost entirely aplanatic, and would, if employed by itself in the original position, yield without stop a sharp but much curved picture.

The front lens of a Voigtlander carte de visite lens of 68 millimetres diameter will give a picture at 330 millimetres focus. The addition of a second lens produces a shortening of the focus and an increase of light.

In the above-mentioned Voigtlander objective, by adding a back lens, the focus is reduced to 230 millimetres and the intensity of light, without taking the absorption of light by the glass into consideration, is increased in the reversed proportion of the square of the focus—*i. e.*, in the proportion of 529 : 1089, or, approximately, 1 : 2.

The more closely the lenses *A* and *B* are brought together the shorter the focus will become, and consequently we will have a corresponding increase in the intensity of light. But we observe that at the same time the curvature of the picture and the spherical aberration for oblique rays increase.

	OO.	*O.*	*I.*	*II.*	*III.*	*IV.*
Front lens.						
Equivalent focus in inches,	22.34375	20.125	17.9219	15.750	13.5469	11.3906
Back lens.						
Equivalent focus in inches,	35.46875	31.9219	28.375	24.822	21.2915	17.750
Double objective.						
Equivalent focus in inches,	15.250	13.729	12.0469	10.6875	9.2041	7.6875
Distance of the two objectives.						
Measured from the highest points of the two exterior convex surfaces, . . .	6.833	6.180	5.550	4.900	4.375	3.800
Measured from the mountings, ...	6.700	6.030	5.361	4.690	4.020	3.350
The diameter of the objective is proportioned to the equivalent focus nearly as	1 : 5	1 : 4½	1 : 4	1 : 3½	1 : 3	1 : 2½
The diameter of the objective (3 inches) divided by the focal length, . . .	0.1967	0.2185	0.2490	0.2807	0.3259	0.3902
The squares of the above quotients, ...	0.0387	0.0477	0.0620	0.0789	0.1062	0.1523
When the light of the system of lenses, *OO*, is taken as *I*, then the other systems will be	1.000	1.232	1.602	2.039	2.744	3.935
Abbreviated, ...	1	1¼	1⅗	2	2¾	4
The intensity of light expressed in seconds might be expressed in the following manner, when a given picture, for instance, a carte de visite, should be made with all the lenses at once and all the stops being equal, the time would be	40	32	25	20	$14\frac{6}{11}$	10

S′, *S″* (Fig. 38) are two oblique bundles of rays, parts of which pass completely through the front lens. Those parts, however, which, according to the explanation already made, would cause spherical aberration, are cut off by the mounting, *F*, *F*. The mounting acts as a stop, and by increasing its length a propor-

tional quantity of oblique rays is excluded. It is easy to see that when the lenses A and B are far removed from one another the oblique rays, S, S, will be almost entirely cut off by the mounting; it follows that when the lenses are far apart the field of view will be reduced in size.

Consequently the distance of the two combinations is of much importance. In the commercial lenses which give much light, as, for instance, Mr. Ross's carte stereoscopic lenses, and also his rapid lenses for taking children's pictures, the two combinations are closely moved together, and the picture is very bright, but much curved; when we bring it on the ground-glass without resorting to stops, only a small portion of the picture will appear absolutely sharp.

In the larger objectives, which, comparatively speaking, give less light, the distance between the two objectives is much greater, the focus is longer, but the picture is larger, darker, and less curved.

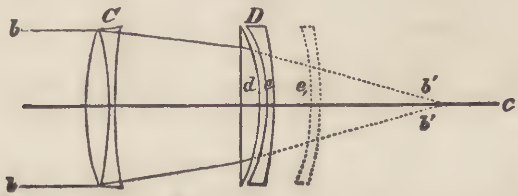
Of equal importance with the distance of the combination is the form. The separation of the crown and flint-glass lenses by a ring is peculiar.

The achromatic rays which have been refracted by the front lens strike the flint-glass lens, f', and suffer so much dispersion that the rays of the *axial* bundle, S, emerge almost parallel, the oblique rays, S', S'', diverge considerably; hence, it follows that for the axial rays, the change in the distance of the two lenses, f' and c', is of trifling importance when compared with the oblique rays.

When the ring is too small the margins of the picture will be deficient in sharpness, and the picture will be too much curved.

An objective which gives a picture of great curvature, and deficient in sharpness at the margin, can often be improved by changing the ring in the back lens. This of course requires great care and many experiments.

FIG. 39.



On the other hand, the distance between the two lenses has great influence on the achromatism; the blue rays, on leaving the flint-glass, diverge more than the yellow ones, or proceed

apparently from a point nearer to the second lens, f, c', Fig. 38, than the latter. By increasing the distance of the two glasses, or what is the same, by increasing the size of the ring, we increase also the length of the chemical focus as compared with the optical one.

We meet with a peculiar construction of the back lens in Dallmeyer's new objectives.

The form is approximately the same as in the old objectives, but the position is reversed—*i. e.*, the flint-glass lens is back, and the crown-glass lens is in front; the distance of the two is variable, as the distance between flint and crown-glass lenses can be regulated by a screw movement.

With larger distance the marginal rays will fall on the lens nearer to its centre, where the dispersion is less; but with a shorter distance the rays will strike nearer the margin, where the dispersion is greater. The lens is so constructed that in the latter case the spherical aberration is almost entirely removed When, by the screw movement, the lenses are removed from each other, a considerable spherical aberration is produced, and instead of one focus, a number of focal points, f', f'', f''', make their appearance. (See Fig. 29, p. 55.)

The ground-glass can be moved a little without interfering particularly with the sharpness of the picture, and securing, at the same time, depth of focus. Experience has taught us, however, that this supposition is not entirely admissible; at all events, the advantages gained by this screw movement are immaterial.

Besides the form, the size of the back lens exercises considerable influence. The lens is generally made wider than the front lens. This is the case in a striking manner in the conical objectives. By increasing the size of the back lens the effectual part of the bundle of rays, S', increases likewise, and which, with smaller lenses, is cut off by the mounting, F, F. The consequence is greater brightness of the margin of the picture, but also, as has been shown above, more spherical aberration of the oblique rays.

The portrait objective is nearly free from distortion.

As an example we give the result of an examination of Voigtlander's carte de visite objective:

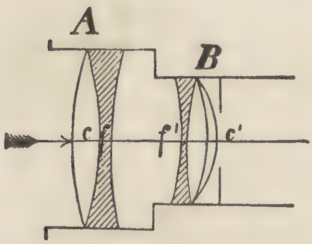
Diameter.	Focus.	Field of view.	Practical field of view with full opening.
68.5 millimetres,	230 millimetres,	43° 50′,	22° 10′.

3. THE ORTHOSCOPIC LENS.

For the copying of drawings, or for taking views of architectural objects, it is of advantage to have an instrument which will give as flat a field as possible. The Orthoscopic lens calculated by Petzval meets these requirements. Formerly this lens, besides those we have described above, was in general use; now, however, the Triplet has generally taken its place.

The Orthoscopic consists of a large concavo-convex front lens, *A*, with cemented crown and flint-glasses, and a combination of lenses, *B*, the back lens, at the same time acting as a dispersing glass. This latter combination consists of a biconcave flint and a concavo-convex crown-glass lens.

FIG. 40.



The stops are generally arranged at the back of the lens.

A drawback to this form of lens is the distortion; the straight lines are generally curved inwards; this circumstance makes it less suitable for the copying of drawings and the taking of architectural objects than the Triplet.

4. THE TRIPLET LENS.

The Triplet objective owes its name to its construction. It consists of three systems of lenses, two achromatic collecting lenses and a smaller dispersing lens placed between them; the diameter can be more or less modified by central stops.

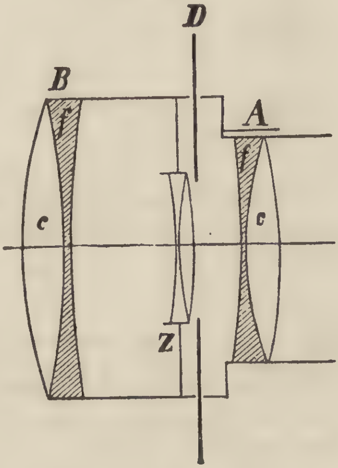
When two equal collecting lenses are combined to a doublet, with central stops, we will get a picture which has the advantage over the Orthoscope of being free from distortion and having greater intensity of light than a single lens of the same focal length, but at the same time the picture would be much curved. To remedy this defect Sutton introduced a concave lens between them. This lens acts as the dispersing one; it makes the rays diverge, and consequently the focus becomes longer.

The more converging oblique rays passing through the margin of the intermediate lens, which latter has greater dispersing power, will experience, consequently, a greater lengthening of the focus than the axial rays which pass through the centre of the lens.

The marked curvature of the picture is almost entirely obviated

by this arrangement. The original triplet of Sutton was symmetrical. Dallmeyer deviates in many respects from Sutton's directions, and his triplets have a small front lens, *A*, and a larger back lens, *B*.

Fig. 41.



The stops, *D*, are in front of the middle lens, *Z*.

The whole system gives, with the full opening, pictures which are sharp in the centre; as, however, the full opening is proportionally larger than in a portrait objective, the lens gives not quite as much light. To extend the sharpness to the margin, the use of stops is necessary.

The Triplet lens covers a larger and flatter field than most portrait lenses, and when correctly constructed it is free from distortion. The lens is frequently employed for the copying of drawings, architectural objects, and landscapes.

The deficiency in light makes them undesirable for portraiture. Dallmeyer states that by removing the middle lens the tube can be used for portraiture. This would shorten the focus considerably and increase the intensity of light, but the field would appear very much curved, and the picture would not be equal to one taken with a common Portrait lens.

Lately Dallmeyer and also Busch have made experiments to increase the "light" of these lenses by increasing the size of the middle lens, and in this way an objective has been constructed which retains the large and flat field of view of the ordinary triplet, but which possesses a greater intensity of light, and thus approaches nearer to the Portrait lens. Busch's improved Triplet is known under the name of the Universal Triplet (so called because it is adapted to so many different purposes).

This Universal Triplet, on account of its large field, does good service in taking groups. A condition for success, however, is a good light.

To show a comparison of the old and new triplet lenses, we give below the result of several experiments:

	Diameter of front lens.	Diameter of middle lens.	Focus.	Field of view.	Size of picture.	Relative size of stop.	Remarks.
Dallmeyer's Triplet, No 1,	32 *m.*	18.5 *m.*	207	70° 40′	44° 30′	0.027	Slight distortion.
Busch's Universal Triplet,	64 *m.*	50.5 *m.*	390	72°	45°	Full opening.	Draws correctly.

The middle lens is in the older triplets smaller than $\frac{1}{10}$ of the focal length, and in the Universal larger than $\frac{1}{8}$ of the focal length. The Universal cannot be used without the middle lens.

5. STEINHEIL'S APLANATIC LENS.

We possess, in the Triplet lens, an objective which combines, with correct drawing properties, a tolerably flat field and considerable intensity of light; but we cannot deny that these results are reached by a rather complicated process. The three lenses consist each of two glasses, each of which has two surfaces, so that in all we have twelve surfaces, to be ground and polished. The large number of surfaces reflects or absorbs a considerable quantity of light.

Steinheil, in Munich, attempted the construction of a lens which, being simpler in composition, should, in regard to its intensity of light, flatness of field, and correctness of drawing, equal the Triplet. Thus originated the Aplanatic objective, which, in a remarkable manner, fulfils all these conditions.

Steinheil's Aplanatic consists of two flatly curved symmetrical lenses, A, B (Fig. 33). Each separate one is composed of two cemented meniscus lenses, consisting however of glasses of different refracting power. The construction is the result of careful calculations by Dr. Steinheil, which so far, however, have not been published.

The Aplanatic gives, with the full opening ($\frac{1}{7}$ of the focal length), a sharp picture of the size of $\frac{2}{3}$ of the focal length, and can, with good light, be used for portraiture, the same as the Universal Triplet; but it is slower than an ordinary portrait combination. What the lens is capable of doing will be best explained by a statement of the result of an examination by a committee of the Photographic Society of Berlin.

Steinheil's Aplanatic Lens, No. 3.

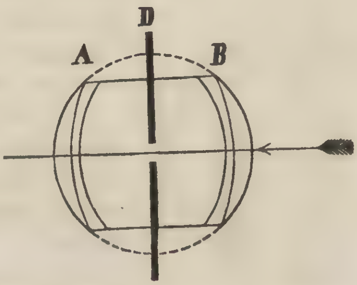
Diameter.	Focus.	Size of picture for portraits.	Land-scape.	Field of view.	Practical size of picture with 0.026 stop.	Remarks.
19‴	10¼″	6¼″	10½″	—	—	According to the statement of price-list.
43 *m.*	296.6 *m.*	6″	—	65° 20′	43° 20′	According to the report of the commission.

6. THE GLOBE LENS AND THE PANTOSCOPE.

The lenses which we have described so far, have only a moderately large field, which, under very favorable circumstances, may extend to 60°. Such a field may be sufficient for most landscape and architectural purposes, but it is inadequate when the photographer has only a short distance between the lens and object at his disposal, a case of frequent occurrence in streets or interiors.

Harrison & Schnitzer, in New York, constructed a lens which is distinguished from former lenses by a very large field of view. The lens is a double objective, *A B*, with symmetrical, strongly curved crown and flint glass lenses, the outer curves of which form a sphere; the lens is provided with stops, *D*.

FIG. 42.



The stops are a necessary part of the objective. While the previously described lenses, Portrait lens, Triplet, and Aplanatic, will give sharp pictures without any stop, the Globe lens will show so much spherical aberration as to make the picture useless.

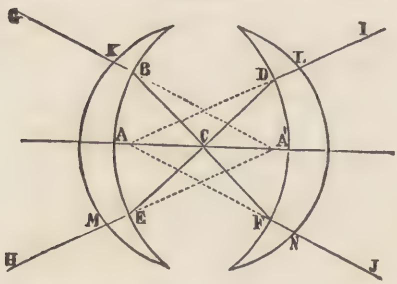
The consequence is that it is inferior in light to the previously described lenses, but excellent in other respects.

The small stop excludes a large quantity of light which strikes the open front lens, and only a small portion which falls nearly vertical on the lens is able to exercise any effect.

The annexed figure will illustrate the course of such a bundle

of rays. The oblique bundles, *L I*, and *N J*, after being refracted by the front lens, pass through the centre of the objective and strike the points *B* and *E;* being here again refracted, they leave the lens parallel to their line of incidence.

FIG. 43.



The original Globe lens of Harrison showed only an angle of 75°.

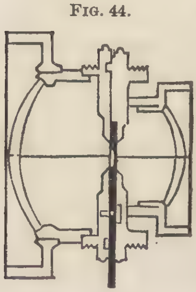
The Ross Doublet shows equal capabilities; its construction, however, is different from that of the Globe lens.

Busch, in Rathenow, has constructed an instrument similar to the Globe lens, which surpasses the latter lens in the size of the picture, and the picture shows the astonishing angle of 90° (field of view 105°). The picture which such a lens furnishes is twice as long as the focus of the lens.

The arrangement of the lens is similar to the Globe, but the external surfaces are not in the same sphere.

In a still more perfect manner Mr. Zentmayer has accomplished the same object by a combination of two strongly convex simple crown-glass lenses. This Zentmayer lens is, particularly in America, where it originated, very generally employed where a short distance and large field of view are required.

FIG. 44.



The back lens is smaller than the front lens; the front lens can be used again as back lens of the next larger combination, an advantage which landscape photographers will fully appreciate.

Any variety of combinations and series of focal lengths might be constructed on the above principle; but the plan adopted is as follows: The most complete set consists of six lenses, the focal lengths of which are—

I, . . .	5.333 inches.	IV, . . .	18 inches.
II, . . .	8 "	V, . . .	27 "
III, . . .	12 "	VI, . . .	40.5 "

These may all be successively arranged in the same mounting,

giving combinations with focal lengths and circular fields at 90°, as follows:

Lenses I and II give a focal length of 3.55 inches, and field 7 inches diameter.
Lenses II and III give a focal length of 5.33 inches, and field $10\frac{1}{4}$ inches diameter.
Lenses III and IV give a focal length of 8 inches, and field 16 inches diameter.
Lenses IV and V give a focal length of 12 inches, and field 24 inches diameter.
Lenses V and VI give a focal length of 18 inches, and field 36 inches diameter.

Thus, with six lenses and one mounting, five different instruments may be successively adjusted in as many minutes, the mounting being so arranged as to fit in the camera either way. To pass from one focal length to the next longer in the series, it is only necessary to take out the smaller lens and put in its place the second size above. Thus, to change 8 inches into 12, lens No. III is replaced by No. V, and the mounting reversed. A little shutter, close to the central diaphragm, serves for "exposing" in place of a cap; and a diaphragm plate is arranged with three holes for each combination, a large one for focussing, a middle one for quick work, and a small one to secure extraordinary sharpness; for it is one of the merits of this lens that a large stop may be used for focussing, and a small one thrown in for the exposure, with not only good, but the very best effect.

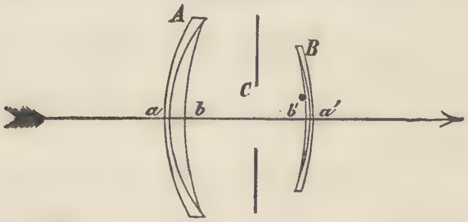
The decrease in the intensity of light towards the margin is a great disadvantage of the objectives with a very large field of view; the margins are frequently under exposed when the centre has received its full exposure; this becomes particularly apparent when the centre of the field contains bright objects, while the margins are occupied by darker ones.

In employing these instruments we have to observe, also, that the perspective is frequently exaggerated; the nearer objects appear too large, while those at a distance are too small.

As the latest in this line we must mention Dallmeyer's Rectilinear lens. This lens consists of two achromatic meniscus lenses, *A* and *B*, with a stop between them. The position of the stop has been selected in such a manner that the bright spot in the centre (ghost) is avoided.

The Rapid Rectilinear lens, lately constructed by Dallmeyer, resembles the older Steinheil lens so much that it may be considered

FIG. 45.



a copy of the latter, in which Dallmeyer has only made a few changes.

ON TESTING OBJECTIVES.

The general method amongst photographers is to take with a new objective a few trial plates. Such trials are very valuable; still the result is always one-sided, as it gives information only in regard to the size of the picture, the sharpness towards the margin, and the difference between visual and chemical focus, also in regard to distortion. The intensity of light is only superficially ascertained, and as for the size of the picture, this in itself forms no criterion of the value of an objective.

We often hear the remark, that a portrait objective, which gives a figure twice as high as the diameter of the lens, must be a good one.

It is only necessary to examine the price-list of the opticians in order to find out that the size of the picture, with objectives of the same opening, varies considerably. So, for instance, the 3-inch lens by Busch (page 67) gives in

			Focus.	Price.
System I,	a picture of	7×9 inches,	12 inches,	46 dollars.
" II,	"	$6 \times 7\frac{1}{2}$ "	$10\frac{7}{10}$ "	51 "
" III,	"	$4\frac{3}{4} \times 6\frac{1}{4}$ "	$9\frac{2}{10}$ "	60 "
" IV,	"	$4\frac{1}{4} \times 5\frac{1}{4}$ "	$7\frac{7}{10}$ "	70 "

If we would take the size of pictures as the test, the first should be the best. The last, however, which gives the smallest picture, is the most expensive.

In what consists the difference?

It is in the focus. With equal opening, the shorter the focus the greater will be the intensity of light of a lens. This shows how im-

portant it is to ascertain the focal length of an objective when we wish to judge of its quality. When the focal length is known, we can form an opinion of the intensity of light.

The intensities of light are, with equal opening, the reverse of the squares of the foci.

When we take, for instance, No. IV and No. I for comparison, the strength of light is proportioned as 12^2 to $7\frac{7}{10}^2$—*i. e.*, as 144 to $59\frac{29}{100}$, or almost as $2\frac{1}{2}$ to 1.

Hence System IV has $2\frac{1}{2}$ times the intensity of light of System I, and in this consists its superiority (see table, page 67, on the relation of intensity of light in the different systems, and the time of exposure necessary for each one). The focal lengths, however, are generally only approximately stated in the different price-lists. Many persons think that focal length is the distance between the ground-glass and the back lens, when the system stands in focus, or what is the same, projects a sharp picture on the ground-glass. This is correct only for the simple lens, but not for a compound combination.

For a combination of lenses, the focus, and the distance of the ground-glass from the back lens, are two entirely different things.

For an example, I will select the Steinheil lens. Its focus, according to the price-list, is $10\frac{1}{4}$ Parisian inches, or 0.276 metre. According to my measurements it was 0.296 metre. Similar discrepancies happen frequently, and as it happens very often that one does not know, by the focus, whether the distance of the back lens from the ground lens, or the actual equivalent focus, is meant, the importance to determine the length of focus becomes evident. Different methods have been recommended. I have tried them all, and consider the following the simplest and most reliable.

The objective which is to be tested, is placed on a long camera; a strip of black paper, of about four inches in length, with parallel sides, is cut out, and afterwards divided again lengthways. The one piece is pasted on a board, or on a piece of Bristol board; the other piece is pasted on the ground-glass; both are pasted in a vertical direction. The objective is now focussed on the black strip, and the camera is moved backward and forward until the image on the ground-glass corresponds exactly in size with the piece pasted on to it. To make the upper line of the image exactly correspond with the same line on the ground-glass, it will only be necessary to fasten with a string the board carrying the black paper to a nail in the wall, and to raise and lower it until the lines coincide; when the lower lines likewise coincide, the instrument is

removed from the camera without changing the position of the latter, and the distance between object and ground-glass is exactly ascertained; by dividing this distance by four we get at the equivalent focus of the lens.

It is advisable to paste a piece of paper with small print on it upon the black strip, as it facilitates focussing.

When we know the focal length, we can draw a very nearly correct conclusion in regard to the intensity of light.

The opening is divided by the focal length, and the square of this figure is found. So is, for instance, the fraction for—

Voigtlander C. de Visite.	Auzoux 3 inch.	Busch's Portrait Triplet.	Steinheil.
$\frac{68.5}{230.4}$	$\frac{76}{350.5}$	$\frac{64}{390}$	$\frac{43.5}{303.06}$

Or expressed in simple figures—

$\frac{1}{3\frac{4}{11}}$	$\frac{1}{4\frac{4}{7}}$	$\frac{1}{6}$	$\frac{1}{7}$

The squares of these figures are—

$\frac{1}{11.3}$	$\frac{1}{21}$	$\frac{1}{36}$	$\frac{1}{49}$

Theoretically, the intensity of light of the different objectives will bear the same relation. Practically, there are many exceptions to this rule; the more or less fine polish, the color and form of the glass, play an important part.

The author had two Dallmeyer stereoscope lenses of the same focus and opening, but the one had much less intensity of light than the other. But, until we possess an exact process for determining the intensity of light, the above calculation will give approximately this important factor.

As important as the determination of the focal length is for finding the intensity of light, so also it serves to determine the extent of the field of view. The lens is screwed to a *very large camera* in order that the circle of light may be completely visible on the ground-glass.

The diameter of the circle should be exactly measured, and transferred to a piece of paper (see *a*, *b*, Fig. 35). In the centre a vertical line should be erected, *d*, *c*, its length being the same as the focal length of the lens, and we next construct the triangle, *a*, *d*, *b*. The *angle* at *d* is the *field of view of the lens.* This angle is easily measured with a protractor.

The possessors of trigonometrical tables do not require this construction, but can determine the angle from the radius of the circle of light and the focus. The tangent of half the angle of the field of view is equal to the radius of the circle of light divided by the focus.

When we take a picture in which the whole circle of light is visible, we will find that only the central part is sharp and fit for use; but by substituting smaller stops the sharpness will extend further and further towards the margins. How far the sharpness is useful for practical purposes depends entirely on individual opinion. Some photographers are in this respect extremely pedantic, while others are satisfied with moderate results.

The nature of the object also (whether portrait, landscape, or reproductions) plays an important part. When we desire to determine how large the actual practically useful field of a lens is, we have to find out the extreme points where the sharpness is still sufficient, and then apply a rule and ascertain the diameter of the practically useful surface.

When we execute the same construction as above, we will find the practical angle of the field of the picture.

The introduction of stops has of course a considerable influence in extending the field; and in comparing the performance of two objectives, the sizes of the stops must not be overlooked. It is, however, incorrect to measure the size of the stop only. In order to get a correct guide, the size of the stop should be divided by the focal length of the respective objective.

The size of the picture is only to be considered when the instrument is nearly in focus with the ground-glass. It is quite different when the picture is removed from the focus. A carte de visite lens, for instance, will give in its focus a picture of about three inches; but an object three inches long, placed in the focus of the lens, would if projected on a screen, or on the ground-glass, be five feet long. The size of the picture is, hence, only relative, when expressed in definite terms, while the angle of the picture remains, under all circumstances, the same.

To test for focal differences, see the chapter on microphotography.

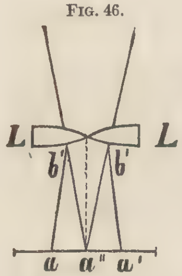
THE STEREOSCOPE.

When we look with both eyes at a near object, the view which each eye obtains of the object will be different. The left eye will see more of the left side, and the right eye will see more of the right side of a body. Both views combined produce the effect of

solidity. In 1838, Wheatstone tried to produce a similar effect by looking at two pictures, one of which represented the object as it would appear to the left eye, the other gave the right-eyed view; and his experiment was successful. He saw the plain figures solid. The figures employed by him were drawn by hand, and consisted of lines and circles. The construction of pictures representing complicated objects, as landscapes and persons, offered greater difficulties; and such pictures became only possible by means of photography. At the same time a handy instrument for viewing these pictures was invented by Brewster, which he called the stereoscope, an instrument which, at the present day, is found in every drawing-room. Stereoscopic pictures and cartes de visite rival each other, and both of these articles have become an incentive for the photographer to furnish the most perfect productions for the lowest price.

Brewster's stereoscope consists of two prismatic pieces of glass, L L', which, when attached to each other by their bases, would form a biconvex lens. Both the prismatic glasses are mounted in a piece of wood in such a manner that the points are opposite to each other, and that both correspond to the position of the eyes. When we now look at a stereoscopic picture, through these glasses, by bringing them close to the eye, and placing the picture at a distance where the objects appear plainest, the two pictures will appear as one, and give a perfectly plastic impression.

Fig. 46.



The coalescence is explained by the fact that the lenses act like prisms—*i. e.*, divert the lenses of the eye in the direction of the refracting edges.

Suppose that a and a' are two corresponding points in the stereoscopic picture, and L and L' the lenses (Fig. 46), then the rays a b and a b' will be so diverted that they will appear as if they proceeded from a single point, a''.

In order that this appearance may take place in a normal manner, it is necessary that the pictures should be mounted at a proper distance from each other. A trial will soon establish the necessary distance. As the stereoscopic glasses are lenses, they act at the same time as magnifiers; they *enlarge the picture.* Lenses have the effect of placing the objects at the distance of most distinct vision, and as this distance is different in different individuals, it follows

that the distance of the glasses from the picture depends on the individuality of the observer.

For this purpose stereoscopes have been made where the glasses can be moved, or where the picture can be brought nearer to or removed further from the glasses.

Generally the picture is near the focus of the lens with which we view it; it is essential also that the focal length of the lenses with which we view a stereoscopic picture, should be of nearly the same length as those with which the picture was taken. When this is not the case a wrong stereoscopic effect will be produced, and this causes the exaggerated perspective in pictures which have been taken with lenses of very short focus, and are viewed with lenses of only slight magnifying power.

Stereoscopic pictures are either taken with a camera with two objectives, the distance between them being about the same as the distance between the eyes ($2\frac{1}{2}$ inches), or they are taken with a single objective by placing the camera first in the position of the right eye, and then the left.

For very distant objects, the distance has to be increased in order to recover the plastic effect; in landscapes this amounts sometimes to as much as several feet. For near objects excessive distance exaggerates the prominent points, and in case of a person, the nose or hands seem to project several feet from the body.

THE PANORAMIC APPARATUS.

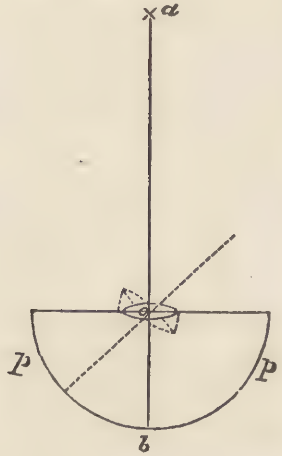
The generality of photographic apparatus has only a very limited field of view, and does not admit of taking a view of considerable lateral extension, such as we frequently meet with at the seashore or in the mountains; for instance, the panorama of the Rigi, or the Faulhorn. Martens, an engraver in Paris, conceived the idea of taking such pictures with a rotating camera, which would successively take in the whole horizon.

He constructed, in 1847, a camera with a cylindrical daguerreotype plate; the plate remained stationary while the camera with the objective revolved; the light acted on the plate through a small slit. It is easily demonstrated that, in spite of the revolving motion of the camera, the picture of the same object must always be projected on the plate in the same spot. The *image* of a point lies always on the straight line which is drawn from the point through the centre of the lens.

When a is such a point, and o the centre of the objective, P, P,

the cylindrical plate, then the image of the point will be on a line, $a\ b$, drawn through the plate from o. When now the objective is moved around its centre (as is indicated in the figure by the dotted lines), then the image of a, according to the principle stated above, will still remain on the same line, $a\ b$ (because a and o do not change their positions), and will fall again on the point b of the plate, and notwithstanding that the objective moves constantly, all the points of the object will be sharply defined in the picture.

FIG. 47.



The above holds good only, of course, when the rays do not form too large an angle with the axis. To prevent this, a diaphragm with a narrow slit is placed opposite the lens, the opening of which is parallel to the axis of rotation, and which moves simultaneously with the objective.

The fault of Martens' apparatus is the cylindrical plate, the preparation of which in the ordinary collodion process offers great difficulties.

Brandon introduced in its place a plane plate, which, during the rotation, rolls itself, so to speak, off the cylindrical surface of the image, following the motions of the objective.

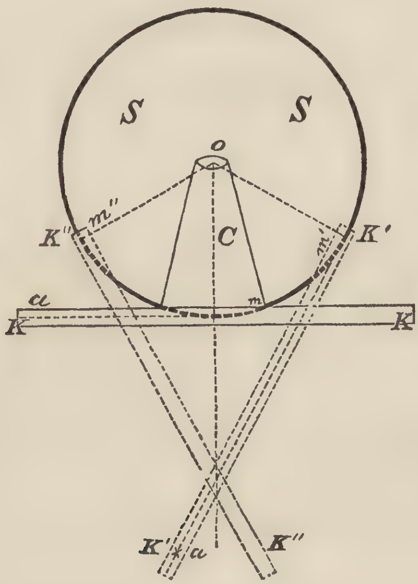
The mechanism, to execute the motion in an exact manner, differs widely, and the opinions vary considerably as to which manner of construction is the most practical.

Generally the camera, C, Fig. 48, with the objective, o, is placed on a horizontal metallic plate, S, S; the camera rests on small wheels and revolves around an axis which passes through the optical centre of the objective.

The wheels are moved by clock-work. The plate-holder runs in a movable groove, as in a carte de visite camera. A cord wound around the disk, S, S, the ends of which run off in the direction of the tangent, and which are fastened to the ends of the plate-holder at a, causes the latter to move, and to occupy successively the positions which, in the annexed figure, are illustrated in three phases,—beginning at K', K', centre at K, K, end of motion at K'', K''.

The pictures obtained with this apparatus are evidently projections on a cylinder unrolling itself. The vertical lines are reproduced vertical, but the horizontal ones, unless they coincide with the horizon of the apparatus, are represented as curves.

FIG. 48.



When we take a house front or a street with this apparatus, the top lines will appear as an upward curved line, while the base lines will be curved in the opposite direction, which effect becomes more unpleasant when the line is very long and far removed from the horizon.

For architectural views this apparatus can only be used to a very limited extent, and a wide-angled lens is decidedly preferable.

PRELIMINARY

WORK IN THE LABORATORY.

THE chemicals necessary for the different photographic processes are generally mixed beforehand ready for use. The especially important mixtures are the *collodion*, the *silver bath*, the *developer*, the *intensifier*, and the *fixing solution*. These fluids are absolutely necessary before one can commence to work, and they must be in such a condition that we can rely on their good qualities. In their preparation, preservation, and treatment the greatest care is necessary, and particularly the greatest cleanliness is to be observed in the preparation of the collodion and nitrate bath. When a mistake has been made it will manifest itself in every plate, and success becomes impossible. The utmost care is therefore the more necessary, as even the smallest homœopathic quantities, which can hardly be traced by analytical tests, when present in the collodion or in the bath, are apt to make all photographic success an illusion.

The author knows hundreds of photographers, who, either from carelessness or ignorance, neglected to clean a funnel, and, without suspecting it, ruined their collodion or nitrate bath, and who afterwards had ten times as much trouble to restore their chemicals to working order, as it would have taken to give to the funnel the most thorough cleaning.

1. PREPARATION OF THE COLLODION.

The great care which has been recommended above refers particularly to the preparation of the collodion. A silver bath is easily mixed, and it can be used at once if the old bath should refuse to work. A new collodion, however, can, under most favorable circumstances, only be used successfully a few days after it has been mixed.

The photographic collodion is a solution of pyroxyline in a mixture of alcohol and ether, with which certain salts are mixed, the so-called iodizing salts; it serves to produce the sensitive film.

When a glass plate is coated with this collodion, a film containing a combination of collodion and this iodizing salt will remain on the glass; when this plate is now dipped into the nitrate bath, the salts of iodine and bromine will decompose, and iodide and bromide of silver (which are very sensitive to light) will take their place on the film, while a combination of nitric acid with a base will remain in the bath.

We will first consider the properties of pyroxyline (gun-cotton). How it is made I will not explain here, for I hardly think that a photographer will attempt to make it himself, as there are plenty of sources from which to get a good and reliable article.

The recently introduced papyroxyline made from paper, is chemically identical with gun-cotton, and possesses the same qualities.

PYROXYLINE AND PLAIN COLLODION.

Pyroxyline is soluble in different substances, as, for instance, in acetic ether. On evaporating the solution it remains as a white powder.

The best photographic solvent is a mixture of alcohol and ether, from which the collodion on evaporation separates as a transparent glutinous film. The properties of this film vary not only with the kind of pyroxyline employed, but depend also on the qualities of the solvents that have been used. *The more rapidly they evaporate the more firm will be the film, and with slow evaporation the film will be correspondingly soft.*

With an excess of ether the film becomes strong and cohesive, contracts easily, and does not adhere firmly to the glass; it can often be removed entirely from the plate without tearing it.

With an excess of alcohol the film is tender and tears easily. This is the case to a still greater extent when the collodion contains water.

When to a good collodion water is added, a precipitate will be formed, which will redissolve on shaking. The collodion is now slimy; the film seems transparent, netted, and very tender. These faults will show themselves when we employ an alcohol containing much water; to obviate it, we have to increase the proportion of alcohol. Here, however, another drawback manifests itself very soon: the ether evaporates and the remaining collodion yields as

tender films as before; such a collodion can be improved again by adding ether to it.

How much alcohol and ether are necessary depends on the raw material. For cotton which shows a tendency to give a slimy and rotten film, much ether and $\frac{1}{8}$ — $\frac{1}{12}$ alcohol should be taken. For cotton which has been prepared at a high temperature, and with a mixture containing much sulphuric acid, and which, in consequence, gives a firm, structureless, rapidly drying, and easily contracting film—*i. e.*, a parchment-like collodion—more alcohol than ether should be used.

The strength of the alcohol is very important. For slimy collodion the alcohol should be absolute, while for a parchment-like sample the alcohol may contain water. Hardwich recommends for the latter, when the alcohol is absolute, 2 parts alcohol to 1 ether.

For hot seasons and climates a collodion with alcohol is to be recommended, as it will otherwise dry too rapidly. Sutton recommends, for hot countries, a pyroxyline which will dissolve in pure alcohol, the so-called alcolen. It is made at a high temperature (80°), but, according to Hardwich, the alcohol not only acts physically, but also *photographically.* It *increases* the *sensitiveness* and the *intensity.* The former is only up to a certain limit increased by the addition of alcohol; when this limit is exceeded a diminution takes place; but it is different with the intensity, which, particularly in warm weather, with a collodion containing much ether, is very feeble.

The porous character of the film certainly exercises an influence here.

In Germany we generally take for plain collodion one-half alcohol and one-half ether. Both must be neutral and free from essential oils. The cotton is weighed out, say, for instance, 20 grammes; to this is added 500 grammes alcohol of at least 95°; better still is absolute alcohol; and when the cotton is perfectly saturated with alcohol, 500 grammes ether, of a specific gravity of 0.725, is added; the bottle is now well shaken, until all the cotton has dissolved; it is now placed for at least a week in a cool place for settlement; when the collodion has become perfectly clear, it is decanted off. I generally keep on hand plain collodion containing two and four per cent. of gun-cotton. The former is for ordinary collodion; the latter is added to give any desired consistency. When all has dissolved, this mixture is tested with litmus paper, to see if it has an acid reaction; should the latter be the case, it has to be neutralized with a pinch of carbonate of soda.

Collodion must be kept in the dark in well-corked bottles. According to its preparation it will keep for a shorter or longer space of time. Its keeping qualities depend in a great measure on the nature of the cotton.

Half-decomposed pyroxyline, which has been made from old linen at a high temperature, will not keep long even if it should work well at first. To test plain collodion for its keeping qualities, it should be well shaken with dry carbonate of potash; if it is good, it must remain colorless for the first two hours; if it turns rapidly brown, it will not keep long.

The ether also has something to do with its permanence. It is often ozonized, and liberates iodine from the metals of iodine that have been added.

Such collodion will work very intense at first, but it will not keep. In oxidizing, aldehyde and acetic acid will be produced, which also act injuriously.

IODIZING SALTS.

The plain collodion, which is the bearer of the picture, may be mixed at once with the sensitive salts of silver, which in this case remain suspended in the collodion. This, however, is not generally done, but the iodide and bromide of silver are formed in the film by adding the iodine and bromine metals to plain collodion, and by dipping the plate coated with this mixture into a solution of nitrate of silver, by double decomposition iodide and bromide of silver are precipitated in the film itself. The addition of the metals of iodine and bromine to plain collodion is called iodizing, and the salts which are employed are called the iodizing salts, and the collodion, after being mixed with these substances, is called iodized collodion, or often simply salted collodion (the former expression is, in so far, incorrect, as not only iodine, but also bromine metals, are added to the collodion).*

We will now consider a little more closely the properties of the iodizing salts and the salted collodion. It is evident that of the numerous iodine and bromine metals only those can be used for salting collodion which are soluble in alcohol and ether.

The following are employed:

Iodide of potassium (K I), atomic weight = 166.12, is a salt free from water, which crystallizes in cubes; it melts easy at glowing

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* The reason why the salts of bromine are also added to the collodion will be explained further on.

heat; when the temperature becomes higher it evaporates; it is easily soluble in water; at 12° C, 1 part of iodide of potassium is dissolved in 0.735 water. The solution of iodide of potassium dissolves iodine in considerable quantities. It does not dissolve readily in alcohol; 1 part K I requires from 40 to 60 parts of strong alcohol, according to Hardwich 180 parts of absolute alcohol. In its crystallized state, it does not change in the light; dissolved in HO, it soon turns yellow in the light, and iodine is liberated. *Its reaction is alkaline.* Dissolved in 5 to 10 HO, no reaction is perceptible; but when a piece is moistened with HO, and placed on violet litmus paper, the latter will after a while assume a wine color (that this change of color does not take place at once is probably owing to a decomposition). Hardwich states that the pure salt changes color in the light; when this is not the case, it is owing to the presence of a free alkali.

Bromide of potassium, atomic weight 119.12, crystallizes, free from water, in cubes, the same as iodide of potassium; is permanent in the air; melts at a red heat; dissolves very readily in water, but very slowly in alcohol, so much so that it will precipitate under double decomposition, when a saturated alcoholic solution of iodide of potassium is replaced by the solution of one of the bromine metals, for instance, bromide of cadmium. According to Hardwich, an ounce of collodion, containing $4\frac{1}{2}$ ether and $3\frac{1}{2}$ alcohol, will only dissolve $\frac{1}{4}$ grain of bromide of potassium. K Br dissolved in 10 parts of water has a neutral reaction; but when pieces of it are moistened with water, and laid on pieces of litmus paper, its reaction is decidedly alkaline.

The difficulty with which iodide and bromide of potassium dissolve in water renders their employment in iodizing collodion rather difficult; it happens not unfrequently that they will crystallize out of the solution, particularly at low temperature, and form precipitates, which in the photographic practice give rise to spots. I employ them only exceptionally.

Iodide of sodium (Na I + 4 HO), atomic weight = 186, crystallizes with 4 atoms of water in small spear-shaped crystals; decomposes in the air. It dissolves very easily in water, and quite freely in alcohol; 100 parts of alcohol of 95 per cent. will dissolve at 15° C, 8.33 parts of iodide of sodium. On account of its solubility, it is preferable to iodide of potassium. In its other qualities it is very similar to iodide of potassium. A great deal of the Na I of commerce is almost free from water.

Bromide of sodium (Na Br + 4 HO), atomic weight = 139,

crystallizes containing a certain amount of water; it is not influenced by exposure to the air; dissolves readily in water, slightly in alcohol, but better than bromide of potassium. The solubility of the pure salt is not known. In the presence of iodide of cadmium 100 parts of alcohol at 95° will dissolve (according to the amount of cadmium) 0.8 to 1.3 iodide of sodium.

Unfortunately iodide of sodium, as well as bromide of sodium, when purchased commercially, are very seldom pure, and occasion, when employed photographically, many inconveniences.

Iodide of ammonium ($N\,H_4I$), atomic weight = 145, is a very unstable salt, which generally is half-decomposed when purchased; it readily parts with iodine and becomes yellow. When fresh its reaction is alkaline; it dissolves in alcohol much more readily than K I and Na I, and must be kept in a dark place. Its impurities are very often $Am\,O\,C\,O_2$ and $S\,O_3$. The yellow mass is made white again by shaking with ether, or by adding a drop of sulphate of ammonia; its solubility in alcohol has caused its general employment in photography.

Bromide of ammonium ($N\,H_4Br$), atomic weight = 98; it is made by the direct action of ammoniacal gas on bromine; nitrogen escapes and $N\,H_4Br$ remains. It is a more constant salt than $N\,H_4I$, and dissolves more readily in alcohol than K I and Na I. 100 parts of alcohol at 95° will dissolve 3 parts of $N\,H_4Br$.

Iodide of lithium (Li I + 6 HO) contains, according to Rammelsberg, 6 equivalents of water; is deliquescent in the air, and turns yellow; dissolves readily in water and alcohol. It is only rarely employed for iodizing.

Bromide of lithium ($Li\,Br^2$); its qualities are not very well known. It dissolves, like Li I, readily in alcohol, and is only exceptionally employed.

Iodide of calcium (Ca I) and *Bromide of calcium* (Ca Br) form salts easily soluble in water, which readily decompose in the air by parting with carbonate of lime.

Iodide of zinc and *Bromide of zinc* form white crystals, which become liquid when exposed to the air; are soluble in water and alcohol, and decompose readily. They are not often employed in photography. The inclination which Zn I possesses to form double salts is interesting; we mention the $N\,H_4$ + Zn I and Ka I + 2 Zn I.

Iodide of cadmium (Cd I), atomic weight = 182.7; it is obtained by heating cadmium foil with iodine and water; the solution yields, on evaporating it, large six-sided plates. It can be fused, and is

free from water; under the influence of light it easily turns yellow; dissolves readily in alcohol and water, and forms plates which have a lustre like mother of pearl; its reaction in solutions is acid; exposure to the air does not change it; it shows a tendency to forming double salts.

$$\left.\begin{array}{l}\mathrm{Ka\ \ I\ Cd\ I} + 2\ \mathrm{HO} \\ \mathrm{Am\ I\ Cd\ I} + 2\ \mathrm{HO} \\ \mathrm{Na\ \ I\ Cd\ I} + 6\ \mathrm{HO}\end{array}\right\}\ \text{according to Croft.}$$

Combined with oxide of cadmium, it forms iodic oxide, which is decomposed by alcohol.

Bromide of cadmium (Cd Br + 4 HO), atomic weight = 171.7; it is obtained in the same way as iodide of cadmium; crystallizes with four equivalents of water in needle shape, which decompose in the air; is easily soluble in water and alcohol, and melts and sublimes at a high temperature; it is apt to form double salts.

$$\mathrm{K\ \ Br} + 2\ \mathrm{Cd\ Br} + \mathrm{HO}\ \text{also}\ \mathrm{Ka\ Br} + \mathrm{Cd\ Br}$$
$$\text{and}\ \mathrm{Na\ Br} + 2\ \mathrm{Cd\ Br} + 5\ \mathrm{HO}\ \text{(Croft).}$$

These double salts have not been exactly determined as yet, but the photographic practice seems to indicate that great solubility in alcohol and greater permanence are the characteristic features. This is the reason why mixtures of cadmium and alkaline salts are preferred for iodizing collodion. Of all the iodizing salts those of cadmium are the most permanent. They would be employed exclusively if their acid reaction would not somewhat impair the sensitiveness of the preparations.

ACTION OF THE IODIZING SALTS.

When different kinds of collodion are mixed with different iodizing salts in equivalent proportions, we find very marked differences in their action, which we cannot expect *a priori*, and which relate, on the one hand, to the fluidity, on the other hand, to the permanency and sensitiveness of the preparation. Of importance are: 1, the physical actions which the salts exert on the collodion. It has been found that the alkaline iodizing salts (potassium, sodium, ammonium, and lithium) make the collodion limpid, while the others (Cd I, Zn I, Cd Br) make the collodion thick (some collodions, which have been prepared with an excess of sulphuric acid, become, on the addition of iodide of potassium, first very thick, and then all at once very limpid).

We notice a similar tendency of making collodion very fluid in some of the alkline carbonates, which are frequently added to the iodizing salts. There are only four salts used in photography which have an acid reaction, namely, iodide and bromide of cadmium, and iodide and bromide of zinc. The others, which have been mentioned above, have an alkaline reaction. It is self-evident that for the former a thinner, for the latter a thicker collodion should be selected—*i. e.*, one which contains more or less pyroxyline.

2. *Permanence.*—In regard to permanence, collodion prepared with cadmium stands at the head of the list; it keeps a long time without turning yellow, while alkaline iodizing salts, in solution, decompose rapidly, and the collodion turns first yellow, next red, and becomes very limpid. The least stable salt of the kind is ammonium, next follows iodide of lithium, and finally iodide of cadmium. The bromine metals do not decompose as easily. The cause of the red color is the oxidation of the alkaline metals, on the one hand by ozone, which is frequently contained in the ether, on the other hand by nitrous acid from the pyroxyline. Sometimes the impurities of the salts are the cause, because they contain alkaline carbonates. The permanency of the collodion is increased when several salts are used for iodizing it; it is probably due to the formation of double salts, which resist decomposition longer (see above, iodide of cadmium). In a similar manner do the salts of bromine promote permanence (Hardwich); the effect is particularly good with collodion containing iodide of ammonium.*

3. A third point is the solubility of the salts. Iodide of potassium, for instance, dissolves only very sparingly, and can only be used under certain conditions. A collodion containing equal parts of alcohol and ether (the former of 0.816) will bear for every 120 parts, 1 part of iodide of potassium (Hardwich); but when we add iodide of cadmium, a more soluble double salt will be formed, consisting of almost equal parts by weight of both the salts. Bromide of potassium dissolves still more sparingly. Collodion

* Concerning the preserving action of the salts of bromine, the author had a curious experience. He prepared two samples of collodion; both contained the same amount of iodide of cadmium and iodide of sodium, but to the one he added bromide of sodium; the collodion containing bromine turned red in a few days, while the collodion containing iodine only, preserved its yellow color for three months. On examination it was found that the bromide of sodium contained sulphuric acid. The same collodion prepared with bromide of cadmium kept splendidly.

containing $4\frac{1}{2}$ ether and $3\frac{1}{2}$ alcohol will not take more than $\frac{1}{4}$ grain per ounce of bromide of potassium (Hardwich). A precipitate is easily formed when we add bromide of cadmium to collodion containing iodide of cadmium. *This is a second reason* for rejecting K I and taking the more soluble sodium and ammonium salts.

Li I and NH_4I dissolve very readily; but their tendency to decomposition destroys the permanence of a preparation containing them; and they are not very easily obtained pure. Of the salts of bromine, the best and most soluble is bromide of cadmium; the next is bromide of ammonium, to which the author gives the preference.*

4. Finally, the photographic qualities have to be considered. These differences do not show themselves much with freshly iodized and pure collodions, which have been mixed with equivalent quantities of different iodine and bromine salts. Observe that a fresh iodide of potassium gives a stronger picture than iodide of ammonium, and the latter gives apparently a stronger picture than iodide of cadmium. The inferior intensity of the iodide of cadmium collodion pictures is probably explained by the acid reaction of the nitrate of cadmium oxide, formed in silvering. In course of time, however, the collodions will change, those containing K I and NH_4I changing the most rapidly; they become less sensitive and turn red and limpid, but will give, with extended exposure, sufficiently intense pictures.

The change in photographic sensitiveness takes place much more rapidly, *simultaneously with an increase of the intensity*, in the presence of organic substances, such as nitro-glucose, grape-sugar; also with collodion which has been prepared at a high temperature and in a very diluted state.

One often finds that a collodion at first turns red, but becomes afterwards lighter. This is explained by the formation of organic reducing bodies, which absorb the iodine, which causes the yellow color.

It only remains to explain why generally a mixture of iodine and bromine salts is employed for salting the collodion.

In order to get a clear understanding about the main point—the

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* The solubility of bromide of sodium is much increased by the presence of cadmium salts. According to two experiments, 30 parts of alcohol containing 0.7 iodide of cadmium and 0.7 iodide of sodium dissolved 0.233 bromide of sodium. While 30 parts of alcohol, containing 1.0 iodide of cadmium and 0.4 iodide of sodium, dissolved 0.317 bromide of sodium. With 1.4 iodide of cadmium 0.4 bromide of sodium was dissolved.

sensitiveness of the collodion—I undertook a number of special experiments. I prepared three different kinds of collodion, to which were added equivalent quantities of chloride of cadmium, bromide of cadmium, and iodide of cadmium. They were sensitized as usual, and a white plaster of Paris cast, partially covered with black drapery, was "taken" with the different collodions. All the three plates were exposed equally long and developed with a solution of sulphate of iron.

The collodion containing iodine gave a very intense picture of the white plaster, but the drapery looked weak, and the outlines were indistinct.

The collodion containing bromine gave a clear but weak picture of the plaster, and did not show a trace of the drapery.

The chlorine collodion did not show a trace of the picture.*

According to the above the pure iodide collodion is photographically the most sensitive.

To complete the experiments a mixed collodion was examined.

Three different kinds of collodion were prepared: 1, a pure iodine collodion; 2, a collodion containing as much iodine as No. 1, and besides $\frac{1}{3}$ of a bromine salt; 3, a collodion with as much iodine as No. 1, and also $\frac{1}{6}$ of a chlorine salt. With these chemicals the plaster of Paris cast and drapery were taken under similar circumstances.

The iodine collodion gave again a very intense but rather "washed" picture of the plaster, and very little detail in the black drapery.

The bromo-iodized collodion and the chloro-iodized collodion gave a less intense, but a clearer picture of the plaster, and much more detail in the black drapery. Some dark folds in the latter, which were scarcely visible in the picture taken with iodized collodion, became plainly visible with the mixed collodion.

Hence, it follows,

Pure collodion mixed with iodine is more sensitive *for strong lights* (plaster, &c.); mixed collodion is more sensitive *for feeble lights.* The latter is consequently employed when we wish to secure details in the shadows.

PREPARATION OF SALTED COLLODION.

The plain collodion must be mixed with the metals of iodine and

* This does not prove the photographic insensibility of the chloride of silver collodion, as with longer exposure a picture would certainly be the result.

bromine. Many photographers add the latter to the oily liquid. This is impractical; generally the salts contain small traces of impurities, which settle only very slowly from the collodion and necessitate a tedious decantation.

It is therefore much more practical to dissolve the salts of iodine and bromine by themselves in alcohol, and to add them after a careful, if possible, double filtration, to the decanted plain collodion.

Such a solution of the salts of iodine and bromine in alcohol is called an iodizer or sensitizer.

Of especial importance is the selection of the sensitizing salts. As for the formulæ that have been recommended for this purpose, their name is legion. It is not my intention here to furnish a collection of formulæ, although amongst the many recipes there are a great many good ones. When we try the collodions of different manufacturers and photographers, we will notice in their qualities very perceptible differences.

Some work *soft*, others weak—*i. e.*, they furnish pictures with much detail in the shadows, but few high lights; others work hard, but brilliant.

Some will yield an intense, others a thin picture. And still all these widely different collodions will give good results in the hands of a person who knows how to handle them.

It is possible to secure with a feeble working collodion a brilliant picture by an illumination rich in contrasts; and, *vice versa*, when we have a collodion which yields too much contrast, we may, by proper illumination, secure a harmonious picture. Also by the proper selection of the developer many errors may be equalized.

But any one who intends to apply the same manner of working to all the different collodions, will condemn much as bad which, in more skilful hands, would secure good results.

On the other hand, we cannot deny that, especially in this article, considerable capital has been made out of the ignorance of photographers, and collodion with the strongest sensitizers—lately even casein and rubidium—have been recommended as the photographer's "philosopher's stone."

On the presence of bromine depends the sensitiveness for dark rays—*i. e.*, details in the shadows and softness; while on the presence of the salts of iodine depends the sensitiveness for bright rays—*i. e.*, the intensity of the high lights; from this the conclusion has been rather rashly drawn that collodion works softer according to the proportion of bromine which it contains; but this is certainly not the case.

Late experiments of the author have demonstrated that a collodion containing two equivalents of iodide of cadmium and one equivalent of bromide of cadmium works softer and is more sensitive than a collodion containing double and four times the quantity of bromide of cadmium in proportion to the iodide of cadmium employed.

When the amount of bromine was still further increased (three equivalents Cd Br and one equivalent Cd I), the resulting collodion showed great sensitiveness for feeble rays, but the high lights were pale; it worked soft, but very weak.*

But, according to my own experiments, the quantities of the iodizing salts act just as strange. I have made two collodions, the one twice as strongly iodized as the other was; the former proved more sensitive and gave a more intense picture than the latter.

For testing collodion nothing is better than a plaster of Paris cast surrounded by black drapery.

For comparative experiments, the most exact coincidence in regard to light, silver bath, and developer, is of the greatest importance.

The following is the formula most generally used by myself:

a. ORDINARY COLLODION.†

15	grains,	1	part of	iodide of cadmium,
7½	"	½	"	iodide of sodium,
7½	"	½	"	bromide of ammonium,
465	"	30	"	alcohol,

are dissolved and filtered.

After filtration, 1 part, by measure, of the filtrate is mixed with 3 parts, by measure, of plain collodion, containing 2 per cent. of pyroxyline.

When the raw collodion has been left to settle until it becomes perfectly clear, and the sensitizing solution has been well filtered, the collodion may be used after three days. The time which iodized collodion will keep is variable. When the pyroxyline which has been employed has a tendency to decomposition, the collodion will soon turn red; so also when the salts are impure. It is most difficult to obtain the iodide of sodium pure.

* 1 equivalent of iodide of cadmium corresponds with about 18 parts by weight. 1 equivalent of bromide of cadmium corresponds with about 17 parts by weight.

† This is the collodion which is known as "Dr. Vogel's Collodion."

b. EQUIVALENT COLLODION.

I can recommend, on the strength of my latest investigations, as a collodion of good keeping qualities, the following:

18 parts	of iodide	of cadmium	are dissolved	in	270 parts	alcohol.
17 "	bromide	"	"	"	" 270	"	"

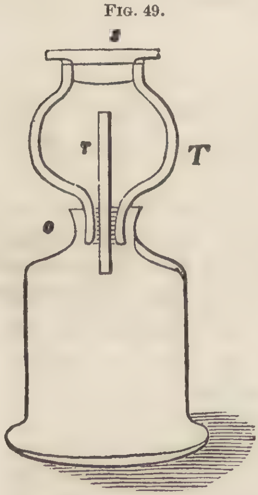
2 parts, by measure, of the iodide of cadmium solution, are mixed with 1 part, by measure, of the bromide of cadmium solution, and 9 parts of plain collodion containing 2 per cent. of pyroxyline.

This collodion contains for 2 equivalents of iodine 1 equivalent of bromine; hence its name. It will keep for years.

Generally, freshly mixed collodion will soon turn yellow, even if the sensitizing salts are colorless. Collodion containing salts of cadmium remains white longer than any other. Some collodions have a tendency to fogging previous to their turning yellow. This can be avoided by making the nitrate bath acid, or by adding to the collodion a few drops of tincture of iodine (which will at once impart a yellow color to it). A collodion rich in alcohol is more apt to fog than a collodion rich in ether.

Some collodions will settle very slowly; after standing for months they will still give streaked and spotted plates. This is particularly the case when they have been made at a low temperature. Such collodion must be filtered: this is a tedious operation, which has to be performed with an apparatus especially designed for this purpose. The apparatus has a funnel, *T*, Fig. 49, which fits exactly into the neck of the bottle; the funnel can be closed by a ground-glass stopper, *s*; washed cotton is loosely packed around the glass tube, *r*. The collodion is placed in the funnel and drops slowly into the lower bottle, while the air from the same escapes into the upper one by the small glass tube. The upper stopper, *s*, prevents the evaporation of the collodion.

FIG. 49.



How to use and how to take care of the collodion will be explained in a subsequent chapter.

2. THE NITRATE OF SILVER BATH.

The functions of the bath are to make the collodion film "sensitive"—*i. e.*, to change the iodine and bromine metals into iodide and bromide of silver.

In former times a diluted solution of silver 1 : 16 to 1 : 20 was used for the sensitive bath, and it is in fact suitable for that purpose still. But it is not advisable, however, to work with so weak a solution of silver, for the perfect sensitizing of the plates progresses only very slowly, and if the collodion contains a great deal of iodine and bromine, this will retard it still more; besides the bath loses with every plate a certain quantity of silver, and will soon be exhausted when the original percentage is very small.

Another point is to be observed,—the solubility of iodide of silver in a solution of nitrate of silver. This causes the so-called "eating away" of the film in a newly made bath, and to prevent that, we either place into a freshly made bath a coated plate, and let it remain in it over night, or we add at once a salt of iodine, which causes the formation of iodide of silver, and lessens the capacity of the bath to dissolve it out of the film.

I always use for the bath the neutral crystallized nitrate of silver; I never employ the fused nitrate, as it frequently contains silver combined with nitrous acid, which often gives rise to great annoyances.

I dissolve

100 parts of nitrate of silver in
1000 " distilled water,

and add 25 parts of a solution containing 1 part of iodide of potassium in 100 parts of water. I never add acid to the bath only when a plate prepared in it appears veiled; diluted nitric acid is then added drop by drop (1 part of nitric acid, 5 parts of water); but only just enough to make the veil disappear. I do not add acetic acid to the bath, as it is apt to give rise to the formation of crystals of acetate of silver; these are very sparingly soluble in the bath solution, and precipitate themselves on the plate in the form of spears, grains, or spots. The addition of sugar of lead, the metals of bromine, and similar salts, which has frequently been recommended, is perfectly superfluous.

3. THE DEVELOPER.

As developer for the negative process, a solution of sulphate of iron is now generally employed. This precipitates the silver from

its solutions as a fine metallic powder, and this precipitate is formed also when we pour an iron solution on a collodion plate which is still *wet from adhering silver solution.* The precipitate forms only on those parts of the plate on which the light has fallen, and thus creates the picture.

In order that the precipitate may not form too rapidly and cause irregular deposits over the whole plate, a diluted and acid solution of sulphate of iron is used.

To give acidity to the developer, acetic acid (so-called glacial acetic acid) is generally used.

Pictures with half tones require a concentrated developer, while for reproductions, without half tones, a diluted solution of iron is preferable.

Take

a. As developer for portraits and landscapes:

3	parts of	sulphate of iron,
3	"	glacial acetic acid,
100	"	water.

When we work with an old nitrate bath, we must add two parts of alcohol. It is not necessary to use distilled water; spring-water, which is not too strongly charged with mineral matter, or river-water, will answer.

b. Developer for reproductions (line engravings):

2½	parts of	sulphate of iron,
3–4	"	glacial acetic acid,
100	"	water;

with an old bath use alcohol as above.

In place of sulphate of iron the sulphate of the oxide of iron and ammonia is sometimes used; 5 parts of sulphate of iron correspond with 7 parts of the sulphate of the oxide of iron and ammonia. Its keeping qualities are its recommendation; it will keep for a long time, while the ordinary sulphate of iron developer has to be prepared fresh every three days.

4. THE INTENSIFIER.

In most cases the developed picture is too weak for printing purposes; its strength must then be increased by intensifiers; this is done by pouring on the plate silver solution mixed with a reducing substance, as, for instance, sulphate of iron, or pyrogallic acid.

From this mixture silver in a powdered state will precipitate and fall on the silver deposit of the picture and increase its intensity.

As principal intensifier a mixture of acid solution of silver combined with a reducing liquid is used. For the latter a solution of pyrogallic acid is generally liked in the presence of acid; it works slowly, very clean, and gives a heavy film. But, like the developer, when dissolved in water, it will not keep long, as it absorbs oxygen and turns brown. The alcoholic solution, however, will keep for years. As the weighing of pyrogallic acid is more troublesome than measuring it, I generally prepare a stock-bottle for that purpose: take

1 part of pyrogallic acid,
10 parts of alcohol.

Dissolve and filter. When well corked this solution will keep for an indefinite length of time. For use, 4 cubic centimetres* are diluted to 100 centimetres with water. Immediately before use it is mixed with an equal volume of the following silver solution:

2	parts of	nitrate of silver,
3	"	citric acid,
100	"	water.

This solution will keep for two weeks.

In summer-time, or when the pyrogallic acid (which sometimes happens) is more energetic, it will be advisable to take 4 parts of citric acid instead of 3. In winter-time, when the reduction should prove too slow, the quantity may be reduced to 1 part. For the reproduction of line engravings, the intensifier should be kept very acid, in order to keep the lines clear.

The iron intensifier deserves the same recommendation as the pyrogallic acid. In the hands of inexperienced persons it is apt to give rise to spots; but it has the advantage that it does not require a washing of the plate before intensifying, and when the proportions are correct it works more rapidly.

We take the above developer (see above) and mix it with an equal quantity of the annexed solution of citrate of silver:

2	parts of	nitrate of silver,
3	"	citric acid,
2–3	"	alcohol,
100	"	water.

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* 1 cubic centimetre = 17 minims.

The other numerous intensifiers, which have frequently been recommended, we cannot mention here; many of them are interesting, but they have not proved themselves as possessing the same practical advantages as those which we have mentioned above. Some of them, which are valuable for some especial branches of photography, we will mention further on.

5. FIXING.

From the developed and intensified picture we must remove the sensitive material, iodide and bromide of silver—on the one hand, in order to make the plate transparent; on the other hand, to protect it against further changes through the influence of light; we take either a solution of

1 part of hyposulphite of soda,
4 to 5 parts of water,

or,

1 part of cyanide of potassium,
25 parts of water.

The solution of "hypo." will keep for several days. The solution of cyanide of potassium decomposes rapidly, and is transformed into potassium formate.

In the atelier, where an abundance of water is constantly at hand, we use hyposulphite of soda; but where the supply of water is limited, when travelling, &c., we use cyanide of potassium.

The latter also dissolves the silver of the picture, and destroys, when it is not quickly removed by washing, the delicate half-tones of the picture.

6. THE VARNISH.

The finished picture requires a covering to protect it against injury by mechanical influences.

Formerly a concentrated solution of gum Arabic was used for this purpose. This would be sufficient when only a limited number of prints are to be taken from the negative, and when the plate is not to be kept for any length of time. Plates which must be kept should be covered with a solution of a rosin in alcohol, consisting principally of shellac. There are as many varnish recipes as there are collodion formulæ; but nowadays it is generally best to buy the varnish ready made from the stockdealer.

For those who wish to prepare it themselves, I publish the following formula:

3	parts of	white shellac,
3	"	sandarac,
40	"	alcohol of 95°.

In his excellent work on retouching, Grasshoff recommends the following varnish:

$2\frac{1}{2}$	parts of	sandarac,
$\frac{1}{2}$	"	camphor,
1	"	venitian turpentine,
$\frac{3}{4}$	"	oil of lavender,
15	"	alcohol.

The addition of turpentine and ethereal oil gives toughness to the varnish. This varnish, without shellac, is excellently adapted to negatives to be retouched with lead-pencil. Very often it is too thick and has to be diluted with alcohol of 95°.

Sometimes the varnish will injure the collodion film; this is prevented by an addition of one per cent. of water.

7. GLASS PLATES.

The glass plate forms a most important substratum for carrying the collodion film in photography, and are used in enormous quantities. They require some preparation before they are suited for the delicate manipulations of the photographic processes. Conditions for their employment are,

a. As nearly as possible perfect transparency, so as to permit the light to pass through unchecked in the printing process. The white and clear plates always have the preference over green glass, or that full of bubbles.

b. Smoothness.—Glass plates which are not absolutely level, will not make perfect contact with the plane of the picture in the camera, and still worse in the printing-frame. In the latter they are apt to break.

c. Cleanliness of the surface.—We generally find two kinds of photographic glass in the market—the so-called Rhenish glass and plate-glass. The former is a more greenish and not always exactly plane and smooth kind of glass; it is made in the same way as window-glass; it is first blown and afterwards flattened out. The other is blown also, but it is afterwards ground, in order to give it a perfectly plane surface.

For smaller pictures, the ordinary glass is good enough, particularly when in its manufacture attention has been given to flatten it with great care, and to store it in a clean place.

But when we require very plane plates, the much more expensive plate-glass should be taken; for instance, for large pictures and reproductions, which have to be mathematically correct. The surface of the glass requires attention. The ordinary Rhenish glass is harder than plate-glass, and less exposed to injury from mechanical or chemical causes. Glass resists chemical influences much less than is generally supposed. Pulverized glass, when boiled with water, gives out a considerable quantity of salt; even when a small quantity of water is evaporated on a glass plate, we notice sometimes that the surface is attacked by it. Solutions of salt exercise a still greater influence, and we frequently notice that drops of water, which have dried on the glass, and salt solutions, leave an indelible stain.

We must convince ourselves that the plates are of suitable size, and will fit in the plate-holder.

The photographer buys his plates generally of suitable size, and very often they are packed with pieces of printed paper between them. This is a bad practice, for the printer's ink is apt to leave greasy spots on the plate, and sometimes the print can be read on the glass by breathing on it. Strips of blotting-paper, for separating the plates from each other, are much preferable.

The rough edge must be removed, as it would tear the cloth in cleaning the plates, and is apt to injure the hands; this is easiest done by drawing a flat file over the edge, or by rubbing the edges of two plates against each other. The splinters should be removed at once, as they will scratch the glass.

The greatest cleanliness in the treatment of glass plates is a condition of primary importance.

All the plates require very careful cleaning. The nature of the cleaning is partly chemical, partly mechanical.

The plate is dipped for a few hours in a solution of either

1 part of raw nitric acid,
1 " water,

which is kept in a dish; or,

1 part of bichromate of potash,
1 " English sulphuric acid,
12 " water.

The latter mixture is recommended by M. Carey Lea. It destroys

organic substances with great energy. Attention should be paid, however, to the fact that crystals of chromate of alum are apt to form and settle on the plates; when this takes place the mixture must be renewed, as it has become useless.

I generally use *nitric acid.*

When a plate is to be used at once, it should be rubbed carefully on both sides, stroke by stroke, with a rag dipped in the acid; after resting for a few minutes, it should be well washed with water, assisting with the hands.

The plates in order to drain are placed on pieces of blotting-paper, and finally rubbed dry with a towel or Canton flannel, which IS KEPT EXCLUSIVELY FOR THIS PURPOSE.

Some operators recommend cleaning the plates with caustic potash or cyanide of potassium. A solution of the strength of about 1 : 10 is rubbed on the plate with a linen swab; the plate is then washed and dried as described above.

A number of cleaned plates must be ready before photographic operations are commenced.

This cleaning should be done with the greatest care, as a plate which is not previously well cleaned can never be brought in the proper condition by rubbing it with chamois leather alone.

It must not be neglected to clean the rough edges also; this is very often overlooked and causes stains and dirty margins in the pictures.

SECTION II.

THE PHOTOGRAPHIC OPERATIONS.

When the preliminary work which has been described in the previous chapter has been performed in the laboratory and in the atelier, the execution of the process may commence. *But we must first convince ourselves that nothing is wanting.*

Nothing happens more frequently to the beginner than that one thing or another has been neglected or overlooked. A plate has been cleaned, collodionized, sensitized, and exposed; but the developer is not ready; or clean glasses are not handy; or the intensifier has to be made: the plate dries, the film contracts, and the previous four or five operations go for nought.

Having a care to see that everything is in order, is of the *utmost importance in portraiture*, for the model as well as the

photographer suffer from neglect. The former would have to go again through the disagreeable operations of posing, placing the head in the head-rest, sitting still, &c., and this is, for the public, little calculated to form an attraction.

The first work in making a photograph is the cleaning of the glass plate.

1. THE CLEANING.

We suppose that a number of plates, which fit in the plate-holder, and have been exposed to acid, washed in water, and dried with the towel, as described above, are at hand. Both sides should be examined by breathing on them; the least impurity will show itself by an *unequal adhesion* of the breath.

When both surfaces appear to be equally clean, the one which is most smooth should be selected for the reception of the picture. In the common glass, the two surfaces vary; the one which has been undermost in the oven, in flattening it, appears covered with numberless small specks, while the other is smoother. One side only requires to be finely polished, as only one side is collodionized; but the reverse side must not become dirty either, as the dirt would be transferred to the silver bath and injure subsequent plates.

The first step in the final cleaning consists in breathing on the plate and rubbing it with a *perfectly clean towel*, which is used for *no other purpose* WHATEVER.

The towel is spread on a clean table; the plate is placed on it, and to avoid touching it with the fingers, is held by turning one end of the towel over the corner of the plate; we now breathe upon it and rub it with the other end of the towel, of which a ball or pad has been formed.

The principal conditions for success are *clean hands and a towel which has been washed with soda only.* When the whole plate has been once rubbed over, not to forget the corners and edges, the plate should be examined by breathing on it, and by examination in reflected light. When the plate still shows spots, the respective places must be rubbed over again; when this fails to remove them, the plate has not been properly treated in the preliminary cleaning process, and must be returned to the acid.

It is perfectly useless to rub a plate with leather, when the breath and towel have failed to clean it; leather will only impart to it a higher polish.

The success of each separate cleaning operation should be ascertained by breathing on the plate.

When the plate appears homogeneous, the *final polishing* should be given to it with chamois leather pads. It is placed in a cleaning-vice, *R* (Fig. 50), which, according to the size of the plate, can be regulated by screws; a little alcohol is poured on the plate and briskly rubbed over it with the pad No. 1; the plate is now polished with pad No. 2, and is finished when it takes the breath equally, showing a blue color.

FIG. 50.

Some prefer to take old collodion instead of alcohol; on account of its containing ether, it removes easily the last traces of grease.

The cleaning is an operation which has to be performed with skill, judgment, and care. The beginner generally commits the error that he tries to clean with the leather pads, plates which have not received sufficient care in the acid bath and preliminary washing. This is time and labor wasted. Dirty hands and towels, and dirty cleaning-rags, often cause much trouble.

Cases where the dirty coat-sleeve draws a line over the cleaned plate occur every day. Many forget also the careful cleaning of the edges and corners.

Very large plates are cleaned in sections. When the plate has been cleaned with the towel, the whole plate is rubbed over with large leather pads; and when the breath indicates spots which are not clean, they are treated separately.

Plates that have been used once before, and which are coated with varnish, are placed in a solution of soda. After a few hours the varnish film is removed. They are washed with water, next with a little acid, then again with water, and finally they are treated like a new plate.

From plates that have been spoiled only a very short time ago, the film is easily removed by rubbing them over, and washing them afterwards with water, when they are fit for use again. Plates on which the collodion has dried should be placed in acid. Old plates, which have been used over and over again, become finally useless; no cleaning will restore them. Many plates are irreparably destroyed by scratches—for instance, by carelessly placing them in the acid, by placing them flat on a table (the latter should never be done). The remedies which are frequently recommended to facilitate the cleaning, such as tincture of iodine, may do in exceptional cases, but for every-day use I do not feel like recommending them.

In the United States a *coating with albumen* has been recommended in place of the tedious cleaning processes described above. On the washed plates, still wet, a filtered solution of the white of one egg in one quart of water is poured. The plate is left to dry in a room free from dust. The plates will keep for a month, and are as good as the ones obtained by careful cleaning. The albumen solution must be prepared fresh every day.

2. THE DUSTING.

When a plate has been rubbed with the leather pads it generally becomes electrical, and attracts dust and fibres, which, if left on the plate, would spoil both collodion and nitrate bath. The plate is left on the drying-rack for a few minutes; it loses its electricity; it is now dusted off very carefully with a camel's hair brush (the duster).

It is best to hold the plate by one corner, in the left hand, in a vertical position.

The duster should not be laid on the table, but hung against the wall. The dusting should be done in the room next to the dark-room.

3. THE COLLODIONIZING.

The covering of a plate with an even film of collodion requires some practice. The beginner should try his skill on worthless plates with old and useless collodion.

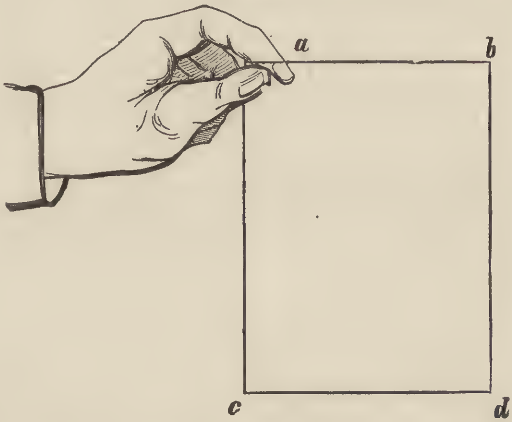
The glass plate (Fig. 51) should be held with the right hand perfectly horizontal by the upper left corner (*a*); a pool of collodion is poured on the centre of the plate; when a sufficient quantity has been poured on, the plate is gently inclined, that the collodion may first flow to the corner *b*, next to *a*, then to *c*, and finally to *d*. It is now inclined gently, by moving the plate in its plane, around *d*. Under *d* the neck of the collodion bottle is placed to receive the excess of the fluid. The plate is now gradually, and while moving it constantly with a rocking motion, returned to the vertical position. The collodion evaporates while draining from the plate, and unless the plate be moved to and fro, it will dry in streaks (diagonal) in the direction of the drainage. The motion should always be in the plane of the plate.

It is also important that the collodion does not collect on the back of the plate; by evaporation it causes unequal drying of the film, and besides imparts impurities to the bath by pieces of collodion becoming detached and floating in the bath. The collodion

should not touch the fingers holding the plate, as it will dissolve fat from the skin, which may cause dark streaks in the picture.

The plate should be kept in constant motion, *and the collodion bottle should be closed again at once, a circumstance which is always neglected by beginners.*

Fig. 51.



To operators, who desire to work very clean, we would recommend to collect the collodion which drains from a plate into a separate bottle; this prevents impurities from getting into the supply-bottle, such as dust from the plates, &c.

When the collodion becomes thicker, and the last drop has ceased to fall, care becomes necessary. When the lower corner has dried so far that the collodion will tear, then the moment has arrived for placing the plate into the silver bath. When the plate is dipped too soon, the film will become weak and peel off in washing. When it is dipped too late, the upper parts, which have become too dry, will either not become sensitive at all, or only superficially, and a dry border will be formed, which will show itself after silvering. It shows of course on the upper margins of the plate where the film is thinnest.

The coating of larger plates is somewhat more difficult. They cannot be held in the hand; they have to be supported in the centre; a corked bottle answers very well for this purpose.

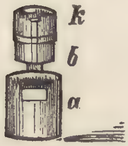
We do not recommend the pneumatic holders; they very often fail, and the loss of a plate is the result.

Large plates are silvered also by placing them on a towel; the towel is formed into a ball; the plate is placed on it, and the collo-

dion is poured on the plate; it requires some nice balancing to coat the whole plate evenly, and the beginner is likely to spoil a few plates before he becomes an expert; but it enables the operator to coat the whole plate without leaving out a corner, and for large-sized plates it is to be recommended.

It would not do to place the plate on the hand; the warmth of the hand would cause a more rapid evaporation of the collodion, and dry spots, where the fingers had supported the plates, would be the result.

FIG. 52.



Collodion bottles, constructed especially for pouring collodion, have been made, and in America they are known as the "Cometless" Collodion Bottle. The mouth is covered by a large cap, *k*, to exclude dust, and the excess of collodion is collected in the funnel, *b*, from whence it flows through a side opening back into the bottle, *a*. They are very good.

4. THE SENSITIZING.

Before we commence coating a plate, we must have the silver bath *ready and in good condition;* for, we have stated above, that the plate must be dipped at the moment it has reached a sufficient degree of dryness. Loss of time makes the result doubtful. The purpose of placing the coated plate into the bath is to transform the salts of iodine and bromine into iodide and bromide of silver. Although this process of decomposition is a very simple one, still there are some mechanical difficulties which sometimes prevent the production of a perfectly homogeneous film of these salts.

The collodion film is alcoholic; the bath is watery. Both repel each other at first, as grease and water would do, and this is the difficulty in getting the bath to flow perfectly even over the plate. Where the flow of the bath has been checked for a moment, streaks are the results. Several methods have been suggested to avoid this. We will describe at first,

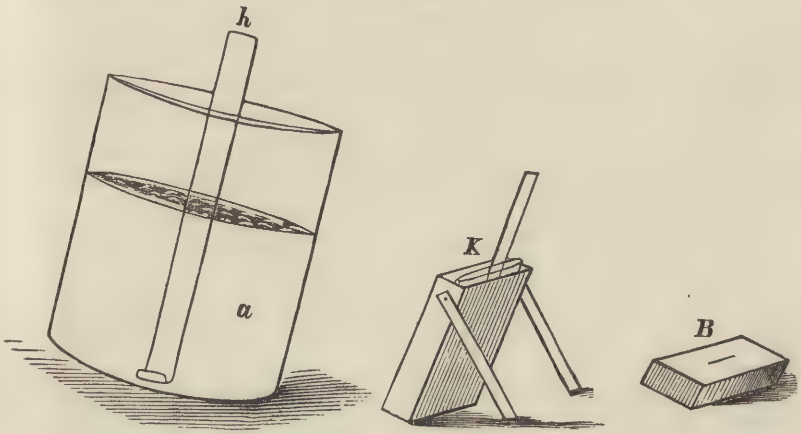
a. THE SENSITIZING IN THE BATH.

The bath is a narrow glass trough corresponding in its shape with the form of the plate *a* (Fig. 53). The filtered silver solution is poured into it. The bath is generally placed into a wooden box of convenient form, and placed in an inclined position. The box, *K*, is provided with a lid having a slit, *B*, in it. The sides of the

bath, front and back, must be curved to prevent the tender collodion film from touching them.

Porcelain baths are inferior to glass; their opacity prevents us from examining the sides and the fluid to see whether everything is perfectly clean, not to mention the occasional peeling off of the glazing.

FIG. 53.



India-rubber baths, on account of the resinous organic matter contained in them, will in course of time affect the bath injuriously.

For *lowering the plate* into the bath an instrument, made either of glass or silver wire, called a *dipper*, is used; the lower end is bent so as to form a hook on which the plate rests. Glass dippers are easily broken. The best are those made of silver wire.

Gutta percha dippers are objectionable for the reasons mentioned above, when speaking of India-rubber baths.

Whoever wishes to use India-rubber goods (they are advantageous for travelling photographers, as they are not liable to breakage), should take care that the solution does not remain longer in contact with it than is absolutely necessary; they should also be washed very frequently.

For the purpose of sensitizing, the plate is placed on the dipper; the corner by which the plate has been held (see Fig. 51) being downward; the plate is lowered into the bath with a steady motion. Any interruption in this steady movement will produce lines, which cross the plate horizontally, and become visible after development.

The alcoholic collodion film repels at first the watery bath, and the latter runs off the plate in greasy lines when it is removed from the bath shortly after immersion.

The plate is moved up and down in the bath until the greasy lines disappear; when this has taken place, and not before, the plate is ready for exposure. With a concentrated bath, and in warm weather, the sensitizing progresses very rapidly; with a low temperature and a weak bath, the process is slow. A plate which has been exposed too soon will show, in the place of the greasy spots and lines, black spots and lines, when the developer is poured on.

The plate, when it is removed from the bath, is placed in the same position on pieces of clean blotting-paper, the top of the plate resting against the wall. In the intervening time, while the plate is draining, we place into the lower corners of the plate-holder small pieces of clean blotting-paper, not omitting, however, to wipe the corners first very carefully; and, finally, we place the plate into the plate-holder, taking care that the four corners are in their proper places, and that the corner which left the bath last occupies also the lower corner in the plate-holder.

All these operations must be performed in the dark-room with a non-actinic light; it should also be avoided to bring the plate too close to a bright gaslight.

The greatest cleanliness of the hands and all and every object which comes in contact with the plate is absolutely necessary.

The sensitizing should be done on a table from which, excepting collodion, all the other chemicals are excluded, particularly hyposulphate of soda.

b. THE SENSITIZING IN DISHES.

This has the advantage that a *very small quantity of silver bath* will be *sufficient;* on the other hand, there is the disadvantage, that the scum has to be removed from the bath *before every immersion of a plate;* after it has been used it has to be poured into a bottle, while in the upright bath the solution can be kept.

The sensitizing in dishes is more suitable for amateurs and small establishments; for large ateliers it is unpractical.

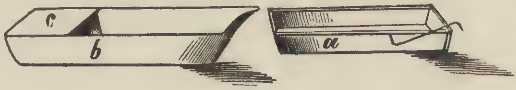
The dishes are made of the same material as the baths—glass, porcelain, and gutta percha. We prefer the glass dishes (see *a*, Fig. 54) for the negative process.

The bath solution is filtered into the dish until it covers the bottom about one-quarter of an inch; the scum is removed by drawing strips of writing-paper over the surface until they appear to be free from dirt; the coated plate is now placed vertical in the dish, the *corner by which it has been held in coating being downward;* the back of the plate touches the side of the dish. The

plate is now lowered, with a very steady motion, until it becomes entirely submerged, the coated side being downward.

The upper margin of the plate is seized with a hook of silver or bone (Fig. 54, *a*), and moved repeatedly up and down until, when

FIG. 54.



viewed in reflected yellow light, the greasy lines have all disappeared; the plate is finally removed from the dish in a vertical position and placed on strips of blotting-paper to drain off the superfluous solution.

When the quantity of fluid in the dish is too small, air-bubbles will collect under the plate and cause round spots when the developer is poured on.

The sensitizing does not progress as evenly with this method as in the bath, and very often streaks and lines will be formed, particularly with certain kinds of collodion.

In such cases it is preferable to immerse the plate with the collodion film uppermost.

For this manipulation a plentiful supply of bath solution is necessary. The plate is placed vertically in the dish as described above, but at the same time the dish is moved in order to hasten the flow of the liquid over the plate; when this is neglected we get very often a plate covered with curved sensitizing lines.

With this method the plate becomes sensitized very rapidly, as the alcohol can readily rise to the surface. The dish is moved until the greasy lines have all disappeared; the plate is lifted out with a rapid motion, so as to wash off small floating particles (pieces of collodion film, &c.). Otherwise we proceed as has been described above.

This method requires more practice, but in the hands of a skilful operator it gives the cleanest plates. For large plates this method is generally employed.

To facilitate the immersion, half-covered dishes have been constructed (Fig. 54, left figure); when such a dish is placed in a vertical position, the solution collects in the covered part, and by rapidly lowering it, the whole plate will be quickly overflowed. It should be so arranged that the wave of the bath flows first over the thickest part of the plate containing the most alcohol, because here the repelling action is the strongest.

In regard to draining, &c., proceed as directed above.

The bath, which is kept in dishes, should always be carefully skimmed previous to preparing a plate; the dish should be kept carefully covered.

The best temperature for a bath is 66° Fahr. In hot summer weather, the bath is improved by placing it in a tub of cold water.

5. THE EXPOSURE

Before placing the plate-holder with the plate into the camera, we should cast a glance over the object to be taken, and also on the ground-glass, to see if everything is in order. The ground-glass is next replaced by the plate-holder, taking great care that the apparatus does not change its position in the least. With equal care must the shutter of the plate-holder be drawn, and particularly for long exposures it is advisable to throw a black cloth over the shutter and plate-holder; when this has been done, the cap is removed from the lens as gently as possible so as to avoid moving the instrument.

How long shall I expose? is the question which we hear from every beginner, and sometimes the experienced operator is doubtful on this point.

The time of exposure depends on the *chemical intensity of the light*, *the brightness of the object to be taken*, *the amount of light which the lens has*, and on *the size of the stops employed.*

Many circumstances have to be taken into account at the same time; experience is the only guide; the only criterion which the photographer can employ is the examination of the picture on the ground-glass. According to its appearance after the picture has been sharply focussed and the proper stop inserted, according to the brightness which it shows on the ground-glass must he regulate the time of exposure.

For portrait and landscape photographers, it may here not be out of place to call attention to the enormous differences in the intensity of light in the different seasons. With a clear sky the light is at 12 o'clock, noon, on the 21st of December of the same intensity as at $6\frac{1}{2}$ o'clock in the evening on the 21st of June. Similar differences exist for all seasons. The study of the chemical meteorology is by no means of secondary interest.

During exposure due care should be taken that the apparatus is not shaken; moving to and fro must be avoided; the objective should be protected *against extraneous light.*

A box surrounding the objective or fastened to the stand will accomplish this.

This precaution is particularly necessary when the atelier is exposed to direct sunlight, or when we work with much top-light. In handling the plate-holder the vertical position should be maintained as much as possible.

It must be remembered that the plate is placed wet into the plate-holder; that the solution will collect on the lower margin; and when we reverse the position, the solution which has collected at the bottom will run back over the plate and generally produce stains.

The principal thing is to operate rapidly. The plate, particularly in warm, dry weather, will only keep moist for a short time; it is therefore necessary that every preparation should be taken beforehand, so that the plate may pass through the different stages rapidly and without any delay.

6. THE DEVELOPMENT.

The exposed plate is carried into the dark-room and placed in its original vertical position. Having satisfied ourselves that the developer, intensifier, fixing-bath, and clean glasses are all in their proper position, and the light in the dark-room being not too strong, the plate is carefully removed from the plate-holder, seizing it in such a manner that it is inclined towards the corner which was lowest in the plate-holder. It will easily be observed that at this lower corner the surplus liquid has collected. This liquid must not run back over the plate, as it may cause streaks and stains, as has been explained above. The developer is therefore poured on the upper corner, with an even sweep, that it may cover at once the whole plate; a part will run off on the opposite corner and take with it the silver solution which may still adhere to it.

For the beginner it will be difficult to pour the developer evenly over the whole plate, as the watery developing solution is repelled by the alcoholic collodion film, and in the places where the flow of the wave has been arrested, lines will show themselves—the so-called developing lines—which no subsequent flowing with the developer will remove.

Neither must the developer be dashed on to the plate too energetically, as that generally produces a bright spot. By pouring the developer on too rapidly, the silver solution is removed from the place where the developer strikes the plate, and the picture-forming

material is reduced in quantity; the pouring of the developer must be practiced before perfect results can be expected.

It is further to be observed, that the upper margin, upon which the developer is poured, must be coated with a film sufficiently strong to resist the shock; for this purpose I recommend placing the thickest part of the film (the part from which the collodion has been drained back into the bottle) uppermost into the plate-holder, and by following the above directions it will come in the proper position in the development.

When the developer covers the plate, the picture becomes visible. When this takes place too rapidly, then the plate has been over-exposed; when it takes place very slowly, the plate is under-exposed. With a normal development the high lights appear first; in a portrait, for instance, the white linen (shirt-bosom), &c., next the face and hands appear, then the light vest or pants, the furniture and draperies, and finally the dark coat. The appearance of the picture should be watched with the greatest care; the developer should be moved in every direction, and fresh solution should be added when necessary. The dark shadows must be watched (particularly the folds in a dark coat in a portrait, or the foliage in a landscape) to see if all the details come out properly. It is of course necessary to be perfectly familiar with the original in order to judge correctly. When, in spite of long-continued development, the details in the shadows do not appear, then the plate has been under-exposed, *and no subsequent operation will remedy this defect.*

An over-exposed plate will show all the details in the shadows, but the contrasts which constitute the beauty of a picture are wanting. The plate is monotonous and yields similar prints.

The transitions from light to shade are, in an under-exposed plate, generally too abrupt, or, as the photographers call it, they are hard.

Long experience is the only thing which will enable us to decide certainly when a plate has received the proper exposure.

When the plate has been fully developed, the developer is washed off, the back of the plate is washed with the hand, and the plate is examined by transmitted light. When the plate is faulty, no further operation is necessary; the plate is simply cleaned and used over again. When, however, it appears clear and transparent in the shadows, with sufficient detail in the dark parts, soft in the half-tones, sharp, and free from spots, then it should be intensified.

7. THE INTENSIFICATION.

This is generally done with a solution of pyrogallic acid; the experienced operator will succeed, however, with the ordinary iron developer.

With a brilliant, intense light, some collodions will give pictures which do not require any strengthening; but in many cases we cannot well do without it.

A small quantity of the watery pyrogallic solution is poured into a clean glass, and an equal quantity of a solution of nitrate of silver is added; the mixture is at once poured upon the plate; by moving it to and fro the liquid will spread over the whole plate, leaving no spot uncovered; after a little while the intensifier is poured back into the glass, while at the same time the plate is examined by transmitted light. The spots on the back of the plate, which are easily removed with the finger, must not mislead us.

When the plate has reached the necessary density (the determination of which is purely a matter of experience), the intensifier must be washed off at once; if the plate has not reached the necessary density, the intensifier is poured on again, provided that the liquid is still clear; a brownish tint does not hurt.

If it has become turbid, it must be rejected, and a fresh solution of pyrogallic acid and silver is poured on.

Sometimes a bluish precipitate will form in the shadows; when this takes place it is an indication that the intensifier is not sufficiently acid.

When the plate has reached sufficient density, and has been washed thoroughly, it is ready for fixing.

When we intensify with iron solution, equal to twice as much nitrate of silver solution should be mixed with the iron, and poured upon the plate, after development, without previous washing.

The intensification progresses as rapidly and comfortably as with the pyrogallic acid solution. Sometimes, however, the intensifier does not mix readily with the developer which may still remain on the plate; the liquid containing the most alcohol will repel the one containing the least; this must be remedied by giving an equal quantity of alcohol to both. When this is neglected, spots are likely to result.

With landscapes and portraits intensifying is comparatively an easy work. With reproductions, however, as for instance copies of drawings, it requires more time and great care. The fine lines

become easily veiled, or the plate is unequal, when the intensifier has not covered the whole plate equally.

The place on which the intensifier is poured becomes first generally a little darker, a circumstance which in portraiture can be turned to advantage by pouring the liquid on the head, and thus giving to it additional density.

The beginner should remember that the intensifier makes the plate only denser and richer in contrast, but does not add to the details. It is, hence, useless to try to improve an under-exposed plate by intensifying it.

Concerning intensification, after fixing, we will speak further on.

8. THE FIXING.

When the intensified plate has been washed (sufficiently to remove the remnant of silver solution), and when the back has been rubbed clean, a solution of

1 part of hyposulphite of soda,
4 parts of water,

or,

1 part of cyanide of potassium,
25 parts of water, is applied.

Either solution dissolves the iodide and bromide of silver out of the film by forming double salts.

The cyanide of potassium affects the plate a little, because it dissolves in the presence of oxygen the gray silver, forming the outlines of the picture.

This is of advantage for plates where the intensification has been carried on too far, but for thin negatives it is a disadvantage. In the latter case close watching is necessary, and when the last trace of iodide of silver has disappeared, the plate should be washed at once with water.

Hyposulphite of soda does not affect the plates, but its action is slower than that of cyanide of potassium. When the solution is old or very diluted, in flowing it unevenly over the plate, it is apt to form black lines, the so-called fixing lines.

It is necessary to wash the fixed plates thoroughly in water to remove the soda, or it will afterwards decompose in the picture and cause its destruction.

Plates which have been fixed with cyanide of potassium are easier washed. The proper point is ascertained by placing a drop of the water, dripping from the plate, on the back of the hand and

tasting it. The smallest quantity of cyanide will indicate itself by imparting to the water a bitter taste.

(Poisoning is not to be feared unless a person is exceedingly careless; but the liquid should not be tasted until the plate has been washed for some time. Be very careful.) After fixing, the washed plate is placed on clean blotting-paper to dry.

8*a*. THE INTENSIFYING AFTER FIXING.

It has frequently been recommended to postpone the intensification until after the plate has been fixed. When we attempt this in the ordinary manner, with silver salt, we will find that, unless the plate has been washed very carefully after fixing, the plate is apt to become spotted.

This circumstance makes this mode of intensification objectionable.

For intensification after fixing, a number of peculiar *metal salts* have been proposed, which, with the metallic silver of the picture, cause peculiar decompositions, and form pictures of different composition, which offer greater resistance to the passage of chemical rays. The chloride of mercury we mention particularly, also a solution of iodide of mercury in iodide of potassium, also a mixture of red permanganate of potassium and the oxide of uranium. These methods may be of advantage for especial purposes, as, for instance, the production of negatives for the photo-lithographic process. For the ordinary photographer, however, the silver intensifier is preferable, the more so as the permanence of the plate produced by the other methods has not been established as yet.

Of particular importance, however, are these changes in the chemical composition of the film, for the email or enamel process.

9. THE VARNISHING.

The delicate picture on the collodion film would soon be ruined by mechanical injuries (scratches, &c.), if we did not provide it with a covering offering more resistance.

Such a covering is the varnish. The loose particles of the film on the margins of the plate are first removed; the plate is warmed over a lamp, and the varnish is poured on exactly as the collodion is poured on in coating a plate; the excess of varnish is poured back into the bottle, and the plate is placed on paper and left to dry. The back of the plate should be kept clear from varnish, as it will produce unequal drying of the film.

If the plates are too hot, when the varnish is poured on, the plate is apt to become streaked; if too cold, the film will appear dull and less transparent.

Sometimes the varnish will eat away parts of the film; this takes place when it contains too much alcohol and dissolves the collodion film. One per cent. of water added to it will remedy this.

Beginners generally make mistakes in varnishing. Glad to have finished a plate so far, they become careless in this last finishing operation, and spoil many a plate in varnishing.

After varnishing and drying, the backs of the plates are carefully cleaned and put away in boxes or closets, secured against dust and moisture.

SUCCESSION OF THE DIFFERENT OPERATIONS

IN THE

NEGATIVE AND POSITIVE PROCESSES.

I. NEGATIVE PROCESS.

a. PREPARATIONS.

Placing plates in acid. Washing and drying.
Filtering the silver-bath and removing the scum.
Making the developer, intensifier, and fixing solution.
Dipper, plate-holder, clean glasses, and filtering-paper should always be in readiness.
Preparation of the model and the camera (focussing).

b. OPERATIONS.

Cleaning the plates (with breath and towels, chamois, and alcohol).
Dusting (the duster not to be placed on the tables).
Pouring the collodion (the collodion must not be shaken, and the bottle must be re-closed immediately).
Drying the film (until the last drop commences to congeal, and the film on the corner, where the collodion has been poured off, tears in patches).
Immersion in the silver-bath (the corner by which the plate has been held, should be immersed first, and when the silvering is done with a dish, the liquid should be scummed before every immersion).
Moving the plate in the bath (until the greasy lines have disappeared).
Taking the plate from the bath and draining on clean blotting-paper.
Placing pieces of blotting-paper in the plate-holder.
Placing the plate in the holder.
Closing the holder.

Carrying the plate to the atelier (holding the holder vertical).
Readjustment of the focus (to see if anything has been changed).
Placing the holder in the camera (without shaking).
Opening the shutter (carefully).
Exposure (opening and closing the lens without shaking the camera).
Closing the shutter (easily).
Carrying the plate to the dark-room (vertically).
Pouring the developer into a small glass (as directed).
Taking the plate from the holder (cautiously).
Pouring the developer on the upper corner of the plate (moving the plate and controlling the development).
Short washing.
Intensifying (continually watching, by transmitted light).
Short washing.
Fixing.
Long-continued washing.
Drying.
Warming the plate.
Varnishing.

These are the twenty-eight consecutive operations which have to be performed with perfect accuracy when we wish to obtain a perfect picture.

For the convenience of the practical worker, we add the operations of the printing process, although they are especially explained further on in the book.

II. POSITIVE PRINTING PROCESS.

a. PREPARATIONS.

Filtering and scumming.
Cutting albumen paper.

b. OPERATIONS.

Sensitizing (in a dark-room).
Drying (in a dark-room).
Cleaning the negative.
Preparing the negative.
Placing the paper and negative in the printing-frame (in a dark-room).

Printing (placing the frame in diffused or sun-light).
Examining the prints (in a place not too light).
Washing (in four waters).
Toning.
Placing the prints in water.
Fixing (for 10 minutes).
Placing the fixed prints in water.
Continued washing.
Drying (on strings or with clips).
Trimming, mounting, removing spots, rolling.

SECTION III.

THE CARE OF THE PHOTOGRAPHIC APPARATUS AND THE CHEMICALS.

In the previous chapter we have especially explained the practice of the negative process, the arrangement of the apparatus, the composition of the chemicals, and all the precautions and little tricks which are necessary for the successful practice of the various photographic processes.

If the relations, under which the respective operations are carried on, would always remain the same, it would hardly be necessary to add anything to the previous chapter. But all things in this world are subject to endless variations, and this general law extends of course to photographic apparatus and chemicals. Unfortunately, these changes are generally for the worse instead of for the better, and necessitate a constant mending and doctoring to keep the respective articles in their proper condition. The labor necessary to accomplish this end, we will condense under the title *care*, and we will commence with

THE CARE OF THE PHOTOGRAPHIC LENSES.

Of all the necessities of the atelier. the photographic lenses appear to be the most lasting, excepting of course their liability to breakage. However, they are also exposed to danger, particularly through the influence of dust. This substance penetrates through the slit for the stops into the interior of the tube, collects on the lenses, and absorbs of course a portion of the light. Openings through which dust can penetrate should be kept closed as much as possible. The objectives should occasionally be taken apart, and the

surfaces of the lenses should be cleaned with soft leather. Sometimes the interior black mounting of the lenses suffers; the black coating rubs off, becomes glossy, and gives rise to unpleasant reflections. The bright spots should be brushed over with a solution of shellac to which lampblack has been added.

It must be remembered that flint-glass is softer than crown-glass, and must be handled with greater care.

CARE OF THE CAMERAS.

The photographic cameras, as well as the lenses, are exposed to the injurious influences of dust. Frequently, when the bellows are pushed in, a quantity of dust escapes from the interior, which collects on the plate and gives rise to holes and spots. Frequent dusting with duster and bellows is here necessary.

The *plate-holders* are the most exposed to injury and destruction. The silver solution from the moist plates drips from the plate, collects on the holder, penetrates into the wood, and causes decomposition. Many peculiar organic substances are thus formed, which dissolve in the liquid which drips from a new plate, and on long exposure penetrate into the collodion film, and on development give rise to the so-called "mossy" spots.

This phenomenon manifests itself most frequently with composition corners, as these offer to the silver solution a wider road into the interior of the wood than corners of solid glass or silver wire. The lower corners of the plate-holder are particularly exposed to this influence.

To prevent the saturation of the plate-holder with silver solution, it is best to dip the lower corners of the holder into melted paraffine.

The perfectly dry and clean corners of the plate-holder should be dipped for five minutes in melted paraffine; this preserves the wood to an extraordinary degree.

When we wish to prepare old plate-holders in the same manner, the silver solution, which has previously penetrated into the wood, must first be removed; for this purpose the lower corners of the holder should be immersed for from five to ten minutes in hot water; after this they should be carefully washed under a spigot, dried, and afterwards immersed in melted paraffine.

When the holders have completely cooled, the superfluous paraffine should be scraped off.

Remele recommends, in place of paraffine, the varnishing of the

holder. This mode of preservation, however, has to be repeated monthly, and it only forms a substitute where paraffine is not accessible.

The utmost cleanliness is necessary for the preservation of the plate-holder. After every exposure, the adhering liquid should be removed with blotting-paper, and the holder should be frequently washed under the tap.

New holders give trouble very often by the detachment of small particles of wood or varnish, and do not become perfectly reliable until all these particles have been brushed away by continued practice.

All the wooden parts of the apparatus should be provided with brass strips to prevent warping.

In hot summers the very best of apparatus will warp. Placing moist blotting-pads inside the cameras, or covering them with moist cloths or blankets, is the best remedy, and it is particularly recommended to landscape photographers.

CARE OF THE GLASS PLATES.

Fresh plates are generally stored away with layers of paper between them. But even the best paper is not clean enough, and leaves an impression on the plate when it remains sufficiently long in contact with it.

For preserving clean plates, plate-boxes are in general use; the grooves should be as clean as possible, and the space between the plates should be ample. We very often find plate-boxes in the market which are high enough and wide enough, but in which the grooves are so narrow that the plates get broken by forcing them in.

Plates that have been cleaned, and are not used the same day, should be rubbed over with leather before they are used.

Cleaned plates for travelling should be packed with margins of pasteboard, when no plate-boxes are at the disposal of the photographer. Such margins are easily made, and the centre of the plates will be protected.

Great care should be taken not to scratch the plates. They should never be laid flat on the table, and they should only be rubbed with cloths which are perfectly free from dust. We should never forget to clean the rough margins. Plates that have been used once before require a different treatment.

When the picture on being developed proves useless, the plate should be cleaned at once, dried with a towel, and be polished.

Plates over which the chemicals have been poured should never be allowed to dry. By permitting salts or even water to dry upon them, they may become affected to a degree that even an immersion in acid or caustic soda will fail to clean them.

Fixed plates, that have not been varnished, should be placed at once into nitric acid.

Varnished plates, that are unfit for use, should be placed for twelve hours in a concentrated solution of carbonate of soda; they should then be washed, and when the film has become perfectly loose, the plates should be placed for a short time in acid previous to being cleaned. By the abrasion of the corners of the plates, a deposit of glass-sand will form at the bottom of the dishes, which will scratch the plates; it is, therefore, better to place flat pieces of wood at the bottom of the dishes, and to let the plates rest on them.

When immersing and when removing the plates care should be taken not to scratch them.

CARE OF THE COLLODION.

Collodion forms the basis of the photographic negative pictures; it is for the photographer of more importance than the paper for the draughtsman. It not only acts mechanically by fixing the sensitive film to the glass, but also chemically by containing besides the indifferent pyroxyline a whole line of products of disintegration, which have a material influence on the chemical and physical properties of the film.

The care of the collodion is consequently of much importance for the photographer who desires to secure equal results always.

The changes which iodized collodions suffer manifest themselves by a change of color, first yellow and then red, and by a decrease of sensitiveness. In these changes free iodine, which remains dissolved in the collodion, separates from the liquid, and gives rise to the formation of free nitric acid in the bath, which will impair the sensitiveness of the plate.

The salts of cadmium have the least tendency to turning the collodion red, while the salts of ammonium have the greatest. While the collodion turns red, it becomes more fluid, and finally so limpid that it does not secure a homogeneous or tenacious film.

It has been recommended to shake collodion which has turned

red, with carbonate of soda, respectively with metallic cadmium, and to let it settle. These bodies will absorb the iodine and restore the bright color of the collodion, but at the same time the plates will have a tendency to fogginess, probably in consequence of the formation of alkaline salts, which are partially soluble in collodion, for instance Cd I and Cd O.

It is much more preferable to mix the red collodion with cadmium collodion. The latter will remain white for months; it is somewhat thick, and by mixing it with red collodion we will get the desired consistency and color very often.

Any one who works with cadmium collodion exclusively will very seldom or never complain about red collodion. For other mixtures, which have a tendency to turning red, it is recommended to preserve the plain collodion and the iodizer separately.

In this case the fluids are mixed in such quantities as experience has taught will be consumed in a short space of time.

Besides the disengagement of iodine a change in the proportion of alcohol and ether takes place, as well as the introduction of impurities, such as dust, &c.

The excess of collodion which has been poured on the plate is generally returned to the bottle. But this excess has lost a part of its dissolving media by evaporation, and of course more of the fugitive ether than of the less fugitive alcohol.

Hence, what is poured back into the bottle is thicker and richer in alcohol. With very careful management this does not matter much; under favorable circumstances a bottle of collodion can be used all but a very small remnant. And if this remnant should be too thick, it should be diluted with $\frac{1}{4}$ or $\frac{1}{3}$ of a mixture of 3 parts of alcohol to 5 parts of ether.

But much more annoying than this loss of fluidity is the accumulation of dust and other impurities. Small traces of dust are washed into the collodion-bottle with the excess which is returned from the plate; with every plate this quantity is increased, and finally the collodion will work uneven.

This is more frequently the case when travelling, where we have to contend more with dust than at home; the annoyance is increased also with larger plates.

The rough corners of the plates exercise a very injurious influence, as they form receptacles for dust and other impurities, which is only too easily overlooked and returned to the collodion. It happens quite frequently that the grooves of the plate-boxes are filled with impurities, all of which help to spoil the collodion.

All these evils can be avoided by returning the excess of collodion to a separate bottle; this collodion is by no means useless; it should be left to settle for a week or so, and the pure liquid can then be decanted and used.

That the neck of the collodion-bottle should always be kept clean is a matter of course. A bell-glass should be placed over the stock-bottle. When no special collodion-bottle is employed, the neck of the bottle should be kept perfectly clean by wiping it with the finger, and the first few drops should be thrown away before pouring the collodion on the plate.

The bottle should be corked immediately after the plate has been collodionized.

THE CARE OF THE SILVER-BATH.

A correctly prepared silver-bath can be kept in good order for a long time with careful treatment. The conditions are to keep it as nearly as possible free from mechanical and chemical impurities. The former present themselves very soon in the shape of detached pieces of the film and dust.

Frequent filtering is consequently a matter of course, and still it does sometimes happen that this does not purify a bath, but has just the contrary effect. A photographer of my acquaintance tells me of such a case. He unfortunately employed a filtering-paper containing a large quantity of the salts of sulphuric acid.* These are thrown into the bath and give rise to the formation of sulphate of silver, which attaches itself in needle-shaped crystals to the plate, and causes spots.

A very pure filtering-paper should be selected. Sometimes a greasy film remains on the surface after filtering. In dishes this does not escape observation as easily as in the bath. The film should be removed with strips of writing-paper, which are drawn over the liquid.

If a silver-bath did not suffer any other damage in the preparation of the plates than the loss of silver, it would be possible to use it to the last drop, similar to a positive bath; but this is unfortunately not the case.

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* To test the paper for these substances, it is necessary to soak it in water, to pour off the clear liquid, and to add a solution of nitrate of baryta; when the salts of sulphuric acid are present, a precipitate of sulphate of baryta will be formed.

Every collodion contains, besides the salts of iodine and bromine and pyroxyline, also the organic products of decomposition. With every plate a quantity of these, as well as alcohol and ether, is left in the bath, and after a while it will contain, besides the salts of silver, the salts of cadmium, alcohol, and ether, the organic products of decomposition from the collodion and iodide of silver, and acetic acid, formed by the oxidation of the alcohol.

No wonder then that it changes rapidly; that it soon ceases to yield strong and vigorous plates, and furnishes weak negatives instead. Finally a point is reached, where the iodide of silver, which has collected in the bath, collects on the plates and gives rise to pinholes. This occurs particularly in summer-time with a high temperature.

When such a bath is tested for the amount of silver which it contains, it is generally found to be very rich in that substance, having often not lost more than one-half per cent. apparently.

It is evident that such a bath could be restored to its former usefulness if we were able to remove the above-enumerated impurities.

Want of sensitiveness is occasioned by the amount of acetic acid which forms in course of time in the bath from the alcohol and ether. This can be remedied by neutralizing the bath. Formerly the oxide of silver was frequently used for this purpose. This, however, should be rejected, as its action is too slow. Carbonate of lime is not to be recommended either, when it is employed in excess, as is generally the case, for it precipitates a portion of the silver. The best remedy is to employ pure carbonate of soda.

One part is dissolved in ten parts of water, and this is added drop by drop to the bath. A precipitate is formed which, on agitating the liquid, will disappear again completely; a second drop is added, and so on until the precipitate will no longer disappear on shaking the bath.

When the bath is now tested, we will find that its reaction has become slightly alkaline. It is filtered, and to the filtrate one or two drops of diluted nitric acid are added (one part acid to five water); a plate is now taken, and if it shows any fogginess, more acid is added, until the plate becomes clear.

This method of testing appears somewhat complicated, and some may think that litmus-paper would answer as well; but this is not the case. With the latter we often get too much acid in the bath.

When an old bath commences to yield weak negatives, which besides have a tendency to show lines and streaks, it generally contains

organic substances. In such a case the addition of soda would not do much good, for it would not remove the organic substances. Photographers usually neutralize the bath, and place it afterwards in the sun. This is very good when we have plenty of sunlight; unfortunately, however, this is not always to be had, and the perfect purification is slow, requiring sometimes a whole day.

Under these circumstances permanganate of potash, which was first proposed by Dr. Jacobson, is preferable; it was first tried by Mr. E. Crooks.

This splendid preparation has lately been brought into the market in beautiful black crystals, which, when dissolved in water, impart to it an intensely deep red color. The solution itself is *sensitive to light*, and decomposes slowly, forming a brown precipitate (peroxide of manganese). Organic substances discolor the liquid rapidly; the former oxidize, and the permanganic acid is reduced to peroxide of manganese,

$$Mn_2 O_7 = 2 Mn O_2 + O_3,$$

which separates with brownish color. This decomposition takes place already in filtering through paper.

This property of destroying organic bodies makes this substance very valuable in removing organic matter from the bath. One part of the permanganate is dissolved in fifty parts of water. This solution is added drop by drop to the bath which is to be restored. If it contains much organic matter, the first drops will almost immediately be discolored; the solution should gradually be added until the last drop is no longer discolored, and the bath assumes a slight rose tinge, which will last for about a minute (after a longer period the tinge from the permanganate will always disappear.)

When a great deal of organic matter has accumulated in the bath, a brownish color will be perceptible beside the rose color; the former is occasioned by peroxide of manganese.

The bath is now filtered. When only a little of the permanganate has been used, it will generally work well without further addition.

When a large quantity has been added, the potash will act as a neutralizer, and one or more drops of nitric acid have to be added, until all tendency to fog has disappeared.

It should be observed that, by the treatment with permanganate of potash, the organic substances have been oxidized, but not destroyed.

The latter can only be accomplished by evaporation and the melting of the solid residue.

This is best done in a porcelain dish over a Berzelius (alcohol) lamp, or a gaslight.

As soon as all the water has evaporated, the silver salt becomes a tough mass, from which reddish fumes escape. The gray color is caused by precipitated metallic silver. The dish is now allowed to cool; the solid salt is dissolved in a little water placed on the fire, and when it boils, a few drops of nitric acid are carefully added. The cloudy mass on being heated will all at once become as clear as water.

Evaporate once more to dryness, and heat carefully to the melting-point; let it cool, and now dissolve the salt in ten parts of water. When the bath gives veiled pictures, acid should be added, as has been described above.

Another impurity of the bath is an excess of iodide of silver, which forms most readily in a high temperature. Iodide of silver does not separate as easily from a warm solution as from a cold one. When the crystals are large, they form a mealy covering, and the plate will show numerous yellow spots after development; when they are small, they give rise to pinholes.

To remove iodide of silver, the bath should be diluted with thrice its volume of distilled water, and well shaken. The iodide of silver, which is only slightly soluble in the diluted bath, precipitates almost entirely. It will only be necessary to filter the liquid, and to evaporate it down to the original volume. Very often the bath contains an excess of iodide of silver, without a material admixture of organic substances; in this case it should first be diluted, filtered, and melted, and if necessary treated with the permanganate.

In the presence of organic substances, the iodide of silver will separate much more rapidly than without it.

Another method to restore a bath which precipitates iodide of silver, consists in adding to the bath a fresh solution of silver, free from iodine, and of the same strength as the bath. In warm weather this will answer for a short time only. It is best to prevent the precipitation of iodide of silver by maintaining the bath at a low temperature. This can be done by cold water or ice, or, when neither is handy, by wrapping the bath in a dark, wet cloth, and exposing it to a current of air.

These are the most important methods of taking care of the bath. One impurity, however, cannot be removed by them, *i. e.*, the products of the decomposition of the salts of iodine, the salts of cadmium, and alkalies combined with nitric acid; when these are present in perceptible quantities, not one of the methods mentioned

for restoring the bath will work satisfactorily, and it will always produce pictures weak and without delicacy.

In such a case it is always best to remove the iodide of silver, as has been explained above, by diluting it with thrice its volume of water; next to evaporate it to the strength 1 : 6 or 1 : 8, and to use it as a positive bath. This is much more rational than the ordinary way of throwing such baths into the waste-barrel for reduction.

The practical photographer will do well to have always two silver baths on hand (one for present use, the other as a reserve in case an accident should happen to the first), and very often it is preferable to make a new bath, as generally speaking a "doctored" bath does not work as well as a new one.

CARE OF THE DEVELOPER.

The protosulphate of iron in solution will soon turn red, in consequence of the formation of an ineffectual oxidized salt. Such a red solution contains consequently a less quantity of the active salts of iron than one that has been freshly prepared. This is an advantage when we have to develop pictures without half tones. For this purpose an old developer is to be preferred, but for plates with half tone, as for instance portraits, a freshly made developer is the most advantageous. When a developer has to be kept for a long time, as in travelling, sulphate of iron and ammonia should be taken instead of protosulphate of iron.

CARE OF THE INTENSIFIER.

Watery pyrogallic solution oxidizes rapidly when exposed to the air; it should be prepared fresh every day (see page 115). The solution of silver and citric acid will keep for more than a week. Citric acid appears, however, to be liable to decomposition, and is apt to cause bluish veils on the negative; an addition of 1 per cent. of fresh citric acid will remedy this.

CARE OF THE FIXING BATH.

Solution of cyanide of potassium should be prepared fresh every day.

Hyposulphite of soda solution will keep longer. Continued use and acids will cause decomposition. It should be prepared fresh every four or five days.

CARE OF THE VARNISH.

Varnish is subject to similar changes to the collodion. It becomes thick by the evaporation of the alcohol, and dusty by the varnish which is poured back from the plate into the bottle.* It is advisable to pour the excess of varnish from the negative into a separate bottle. It can be diluted with alcohol, filtered and used like fresh varnish. On the eating away of the collodion film see above (page 118).

CARE OF THE FINISHED NEGATIVE

Will be explained in the chapter on the positive process.

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* It is well to dust the plate, previous to varnishing, with a camel-hair pencil, and loose pieces of collodion film at the edges of the plate should be removed.

THE POSITIVE OR PRINTING PROCESS.

The pictures which are taken with the camera obscura are on glass; when we look at them by holding them to the light they appear negative, while by reflected light and with a dark background they appear positive.

The silver which covers the high lights appears by reflected light grayish-white or bright, while the uncovered transparent shadows show the dark background and appear dark, hence the whole picture appears positive.

On account of the heavy deposit of silver on our negatives the finer details are not visible in the lights. When, however, the exposure has been short, and no intensification has been resorted to, we will get a picture with good details, which in America is called an "ambrotype."

These ambrotypes were much in vogue in the early days of the collodion process. The gray color, however, the reversion of right and left, and their liability to become broken, brought them soon into disfavor, and the public gave the preference to paper pictures, which are made by placing a sensitive paper under a negative and exposing it to light.

The operations necessary for this purpose are called the printing or positive process.

There are two kinds of printing processes:

1. The direct printing process, where the exposure to light is continued until the print has reached the desired intensity.

2. *The indirect printing process*, or printing by development, where the paper is illuminated for only a short time, and the picture is afterwards brought up to the necessary intensity by development. This latter process is analogous to making a negative, and can also be employed in making transparent positives on glass.

The direct printing process is the one which is generally practiced.

From drawings, direct copies can be taken by the aid of the aniline process. Pictures can be made in gold, silver, and pigments;

the negative can be reproduced on stone and metal, and prints can be taken from the latter.

Generally, we understand, when speaking of a photographic printing process, a method of producing a picture by the direct action of light on a sensitive piece of paper. I may mention also the production of silver, iron, or uranium pictures, and the pigment or carbon pictures.

Of all the different printing processes only one has firmly taken hold in practice; it is the silver printing process, or the production of a picture on paper which has been treated with a solution of the salts of silver.

Of all the different processes it is the easiest to manage, yields with the simplest means the most brilliant effects, and would be perfect if the results were permanent, or if the gases containing sulphur would not affect the silver prints in a similar manner in which these gases affect metallic silver, by turning it into a sulphate, which makes them look yellow.

Lately the carbon printing process, on account of the permanence of its results, has been employed for the production of pictures where permanence is the main object, and it is probable that its importance will be more generally acknowledged before long.

A. THE SILVER PRINTING PROCESS.

The principles of this process have already been explained in the chapter on paper. The machinery which is necessary is of a very simple character.

The negative is ready; it is necessary to bring the same in close contact with the sensitive paper, and to expose it to light. The light passes through the negative from all sides; a print can only reproduce itself as a print, when the distance between the paper and the negative film is equal to 0. When the distance is greater the print will appear as a diffused circle of light. The picture will not be sharp. To secure this intimate contact, presses, called printing-frames, are used, and this has given to the process the general name of printing process.

The printing-frames consist of a wooden square *a a*, in which a piece of plate-glass has been inserted, and a cover, *D*, which is divided in the centre and supplied with hinges. This cover is pressed against the negatives by the springs attached to the crossbars, *e e* (see Figs. 55 and 56).

The negative is first placed into the frame with the film upwards;

on this the sensitive paper is placed; a piece of felt or a paper cushion is laid on top of it; next comes the cover, *D;* and the whole is held in place by the springs and crossbars, *e e.*

FIG. 55.

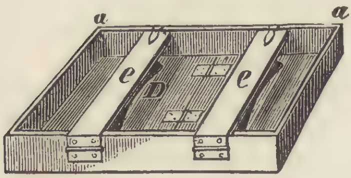
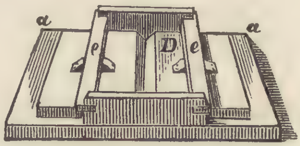


FIG. 56.



In place of the springs, wedges are sometimes used; these are less liable to breakage.

For small plates, such as carte de visite negatives, the plate-glass can be dispensed with. This is of advantage, for it will always absorb some light. Meagher, in England, has constructed printing-frames in which the negative rests on bands of India rubber. This prevents the breakage of negatives which are slightly curved,—a circumstance that frequently takes place when the negative is placed on plate-glass.

PREPARATIONS.

The Positive Silver Bath.

For the sensitizing of the picture-bearing material a solution of silver, the positive bath, is used, similar to that in the negative process.

The strength of the latter was formerly taken very high, 1 part of nitrate of silver to 4—5 parts of water. Recently, however, weaker solutions have been employed. We take now 1 part of nitrate of silver to 8—10 parts of water. To take still more diluted solutions is not advisable. Some kinds of albumen paper are only imperfectly coagulated by diluted silver solutions; 1 part of the organic substance is dissolved in the bath, imparts to it a brown color, and makes it useless.

Even in concentrated solutions, as 1—8 or 1—10, this does sometimes happen.

In such cases the bath should be strengthened. Alkaline baths are more apt to turn brown than acid ones, and a remedy recommends itself, *i. e.*, to make the bath acid by the addition of a few drops of nitric acid. Papers that work well do not require this.

Other additions to the silver bath, as citric acid, tartaric acid, &c., are superfluous.

The question whether strong or weak silver baths are preferable was much discussed a few years ago.

At first sight it would appear as if a weak bath would be more economical, but in many respects this is an error. Every sheet of albumen paper, no matter whether it is placed on a strong or a weak bath, absorbs a certain quantity of silver, which is equivalent to the amount of salt it contains, and which is transformed into chloride of silver; another part forms an albuminate of silver, and still another is absorbed mechanically. It is probable that the last-named quantity is smaller with a weak than with a strong bath (an analysis on this point is not at hand).

It is, however, a question whether the employment of a weak bath is advisable for the sake of this problematical saving.

A weak bath is soon exhausted; it becomes poorer with every sheet floated, and soon the amount of silver will be reduced to a point where it is no longer sufficient for sensitizing, and weak and dull pictures will be the result.

A strong bath loses also by being used, but not nearly in the same proportion as a weak one. It can be used almost to the last drop without serious inconvenience.

A weak bath necessitates long sensitizing; a strong bath sensitizes rapidly and furnishes sheets which, particularly in dull weather, will print much more brilliant than those which have been floated on a weak solution.

Any one who desires to work with a weak bath should take notice of what has been said above; from time to time he should test the strength of the bath (see below the test for nitrate of silver), and fresh nitrate should be added frequently to maintain the standard.

Strong baths do not require this care.

The consumption of silver in the positive process is of particular interest. This depends on different factors; partly on the amount of salt, partly on the thickness of the albumen film; sometimes the length of floating exercises an influence; finally, the more or less rapid removal of the paper from the bath, and the strength of the latter, have to be taken into account.

It is no wonder then that the consumption of silver is stated so differently by different observers.

Davanne and Girard state the amount at 3.76 grains per sheet of 17 × 22 inches. Spiller states 3 grains, and Hardwich states not quite 2 grammes.

As these reports differ so widely, Mr. Meicke made a number

of experiments, in the Berlin Academy, to determine the consumption of silver.

500 cubic centimetres of silver bath of the strength of 1 : 8 were made, and from 20 to 25 sheets were floated on it; the bath was tested by Vogel's method for the loss of silver.

The remnant of the bath was again increased to 500 centimetres, and restored to the strength of 1 : 8, and from 20 to 25 sheets were floated on it.

In this manner the bath was strengthened five times in succession, and used over again.

The result was,

From the fresh bath a sheet consumed						2.61	grammes.
"	" once strengthened bath a sheet consumed					2.46	"
"	" twice	"	"	"	"	2.38	"
"	" thrice	"	"	"	"	2.00	"
"	" four times	"	"	"	"	2.17	"

We deduct from this the curious result that the consumption of silver is less in an old and strengthened bath than in a new one containing the same amount of silver, and that the absorption of silver decreases with repeated strengthening.

The cause of this may be sought in the fact that the combination of the alkali with nitric acid increases with every sheet, and exercises a peculiar influence on the absorption of silver.

The average consumption is 2.4 grammes of silver per sheet of paper.

In the atelier of Hirsh Nickel, perhaps the largest establishment in Germany for reproductions, the average amount of silver consumed per sheet is equal to $\frac{1}{14}$ of an ounce, or 2.38 grammes.

The Toning Bath.

The printed picture has an agreeable violet color; it would, however, soon disappear when exposed to the light, as the darkening of the salts of silver would continue, and turn the whole sheet into a homogeneous black. To make it permanent the unaffected salts of silver have to be removed by a fixing agent, such as hyposulphite of soda.

This imparts to the pictures an ugly yellow color. To obviate this, the prints are treated with a solution of gold. They are toned.

The reduced silver of the picture acts on the solution of gold;

chloride of silver is formed, and metallic gold takes the place of the silver.

The silver picture is partially changed into a gold picture, and the more completely so, the longer the action is continued. This has a great influence on the color of the picture; when it has been toned for a short time, the color is brownish; longer toning imparts to it a bluish or slaty tint. The color of these toned pictures is but little affected by the fixing bath. The toning process makes the pictures not only more beautiful, but also more durable. Gold is much less subject to atmospheric influences than silver, and a toned picture resists the action of the atmosphere much better than an untoned one.

Next to the duration of the toning process, the reaction of the gold bath exercises a marked influence on the color of the picture. An acid gold solution imparts to the pictures a brownish color; a neutral solution produces a violet tint; and when the bath is alkaline, the resulting picture will be a bluish violet. Which color is the handsomest or the most suitable is purely a matter of taste, and we find baths of very different reactions in common use. The one recommends this, the next recommends something else.

An important point further is the concentration of the bath. A strong bath acts so energetically on the prints, the color changes so rapidly from brown to blue, that it is scarcely possible to watch the changes. With a strong bath, irregular precipitates are apt to form in consequence of the influence of reducing organic substances. It is well to employ very diluted gold solutions, particularly when these precipitates commence to show themselves. Generally it is well to take 1 part of gold to from 1000 to 2000 parts of water.

Gold is a metal which is very easily reduced from its solutions. The action of light alone is sufficient to precipitate brown or red powdered gold from a gold solution. When the water contains only a minute quantity of organic matter—and that is generally the case—the reduction will take place even in the dark. It is no wonder that the diluted solutions of gold, which we employ in the form of toning baths, suffer decomposition so rapidly, although we ascribe to the acid toning bath an unlimited usefulness.

The fact is the latter are the most permanent, the neutral ones are less so, and the alkaline the least.

The latter sometimes lose, in an hour after toning, their yellow color and their usefulness.

According to the investigations of Davanne and Girard, this is explained by a peculiar action of the alkalies.

When a gold solution is mixed with an alkali, or a salt of an alkaline reaction, a mixture will be formed consisting of

$$Au\,Cl_3 + 4\,Na\,O = Au\,O_3\,Na\,O + 3\,Na\,Cl.$$

The salt of gold will readily be reduced by the silver. After a short time, however, the loosely combined oxygen will combine with the NaCl, particularly in the presence of an excess of a free alkali, and a subchlorate of soda and a peroxide of gold and soda will be formed.*

$$Au\,O_3\,Na\,O + Na\,Cl = Au\,O\,Na\,O + Na\,O\,Cl\,O.$$

The peroxide of gold and soda is in the presence of an excess of an alkali so constant that it cannot be reduced by silver.

When such a bath is mixed with hydrochloric acid, it turns yellow, and chloride of gold is formed. Every bath which has been neutralized by alkalies has to suffer this change. When, however, no alkalies are present in excess, or when they are neutral, they maintain their toning power, as the acid salt of gold which is formed remains reducible in the absence of an excess of an alkali. Only the toning action is somewhat changed.

In a bath which has not been decomposed only one atom of gold will be precipitated in the place of three atoms of silver.

$$Au\,O_3 + 3\,Ag = 3\,Ag\,O + Au.$$

While in a decomposed bath, one atom of gold will take the place of one atom of silver.

$$Au\,O + Ag = Ag\,O + Au.$$

In the latter case the precipitate is more plentiful; the picture retains in such a bath more vigor than in one containing an oxide of gold, in which the intensity is always somewhat reduced. A bath of the former composition is more suitable to the toning of under-printed pictures.

A peculiar kind of toning baths are the so-called soda baths; they are made by adding drop by drop a gold solution to a solution of hyposulphite of soda.

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* The translator is not quite confident that he has given exactly the proper chemical nomenclature; the symbols will, however, explain.

A double salt is formed consisting of hyposulphite of soda and an aureous hyposulphite, which acts analogous to an alkaline bath; but even with an excess of hyposulphite, it remains reducible.

These baths are used after fixing, while otherwise the toning precedes the fixing.

The tones are not so pleasant as the ordinary gold bath. The color is decidedly brownish, and the pictures require a second fixing to give them permanence.

The double salt of Rhodan gold and Rhodan ammonia gives better results.

What has been said above will suffice to make the chemical process of toning understood. We will now give a number of practical formulæ.

NORMAL GOLD SOLUTION, AND THE CONSUMPTION OF GOLD.

We use for the gold bath, solutions of a certain strength of chloride of gold and potassium. This salt, when purchased from the trade, is generally pure, is not influenced by the atmosphere, and is much easier kept than the constantly moist chloride of gold. As a normal gold solution we use

1 part of chloride of gold and potassium,
50 parts of water.

Of this solution we take a certain quantity for immediate use.

On a sheet of paper (17 × 22), about 0.01 gramme metallic gold will be precipitated, besides a certain quantity of the fluid will be taken up by the paper, containing about 0.01 to 0.015 gramme of gold; so that on an average every sheet of paper requires about 0.03 gramme of the gold salt. But, including all the losses, we have to calculate double the quantity of gold, or 0.06 gramme, equal to 1 grain of gold for every sheet of paper.

1. ALKALINE GOLD TONING BATHS.

a. Borax and phosphate of soda bath.

For every sheet of paper

3 parts of normal solution,
1½ " borax, or phosphate of soda, previously dissolved in
200 " water.

The borax solution can be kept on hand in a stock-bottle, and it will only be necessary to measure the proper quantity.

Borax and phosphate of soda are salts with an alkaline reaction; they reduce the bath in exactly the same manner as a free alkali would. The weak boric and phosphoric acids which become free have no marked influence.

The bath will keep only for a short time; it should always be made fresh. When the temperature is low, it is advisable to warm it before use.*

b. CHLORIDE OF LIME BATH.

Many photographers add to their bath a solution of chloride of lime. It makes the bath alkaline and produces black tones. The chloride of lime bath is made by adding to a bath of acetate of soda 0.03 gramme† of chloride of lime. The mixture should be thoroughly shaken, and should be used after three hours. The bath gives black violet tones.

NEUTRAL GOLD BATHS.

a. With Chalk (after Davanne).

A sheet of paper will require

3 cubic centimetres of normal solution,‡
200 water,

chalk, or carbonate of lime, as much as can be placed on the point of a knife.

The mixture has to be shaken for about five minutes and then filtered. The solution will look yellow when freshly made, but will become colorless after a few hours, without, however, losing its toning properties; but it will tone slower. Pure carbonate of lime is preferable to chalk, as the latter contains organic substances which decompose the gold salt.

b. With Bicarbonate of Soda.

Gold solution and water should be taken as above, and a solution of bicarbonate of soda should be added drop by drop, stirring the liquid constantly, until blue litmus-paper is no longer reddened. This bath does not keep; with an excess of soda the bath becomes alkaline, and the tones become black. As mistakes are apt to

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* The author generally uses the borax bath. † Half a grain.

‡ A cubic centimetre is equal to 17 minims.

occur in making this bath, we give the following formula of Mr. England:

3 cubic centimetres of normal gold solution,				
3	"	"	"	a solution of crystallized bicarbonate of soda, 1 : 50,
200	"	"	"	water.

The mixture should be used half an hour after it has been prepared; the bath does not keep, and should always be prepared fresh.

3. ACID TONING BATHS.

The Acetate of Soda Bath.

For every sheet of paper

3 cubic centimetres of normal solution,
2 grammes* of crystallized acetate of soda,
previously dissolved in
200 grammes of water,

should be taken.

The bath should be used twenty-four hours after it has been made, and it is only necessary to strengthen it from time to time with a few drops of normal solution. The bath gives brownish tones.

4. RHODAN GOLD BATH.

I do not recommend hyposulphite of soda baths. Amongst the many that have been suggested, I have not found a single one which has given me satisfaction. But the Rhodan gold bath deserves to be recommended.

It yields the richest gradations in tone that a bath is capable of, according to the length of toning. The fixing with "hypo" changes the tone a little.

The pictures do not require as much overprinting as with other baths, a considerable advantage in dark and cloudy weather. The picture is washed after printing, and placed in the following toning bath:

Gold solution, ...	3 cubic centimetres.
Sulpho-cyanide of ammonium, . .	20 grains.
Previously dissolved in, . . .	100 grains of water.

The picture turns at first pale and reddish, but finally becomes warm and brilliant, and passes from brown to violet, and finally to

* A gramme is equal to 15.434 grains.

black. This bath consumes a little more gold, perhaps as much as 2 grains per sheet of paper.

The bath is kept, and can, by adding from time to time a few drops of gold solution, be used over and over again.

The proportion should be kept in the above toning bath (3 cubic centimetres of normal gold solution contain 0.06 of the gold salt). As for the formula to be selected, we must refer to what has been said above in regard to the neutral, alkaline, and acid bath, which will give the reader sufficient information. It would be superfluous, and a torment for the beginner, to give him more formulæ to select from. Any one who likes black tones should select the carbonate of soda or chloride of lime bath. To any one desiring brown, I recommend the acetate gold bath, and for purple violet the borax or chalk bath. I generally employ the former.

THE FIXING BATH.

Hyposulphite of soda is used for fixing prints; cyanide of potassium is not admissible, as it affects the pictures very much. The Rhodan ammonium has never been used much, partly on account of its high price, partly also because it necessitates the use of two fixing baths.

Take a fresh solution of,

2 parts of hyposulphite of soda.
4–5 " water.

Solutions that have been used previously will decompose rapidly, and the pictures are apt to turn yellow.

THE PAPER.

In the photographic practice of the silver printing process the albumen paper is most generally employed. It is very seldom made in the atelier, but is generally bought from the dealer.

Its quality is, even with the same mode of manufacture, very variable. The white of egg shows in winter different qualities from what it does in summer.

The tendency to change in this least stable substance is so great that it is almost impossible to furnish always the same quality, and the complaints about the albumen paper will continue as long as the silver printing process lives.

Some papers discolor the silver bath in consequence of the dissolution of a part of the organic substances; others turn yellow a short time after sensitizing, tone badly, and become spotted in the fixing bath.

The number of these faults is legion, and their origin is by no means perfectly understood.* Experience has taught us that albumen paper works better when it is not too dry, and that imperfect papers yield better results with a concentrated bath than with a diluted one. It is recommendable to place the paper for twenty-four hours in a damp place, previous to sensitizing. The blisters, which are apt to make their appearance on fixing, particularly in summer-time, are by it avoided. It is a mistake to try to preserve albumen paper with chloride of calcium in closed boxes.

THE PRACTICE OF THE SILVER PRINTING PROCESS.

In the practice of the printing process a *perfect negative* is supposed to be at hand. The back of it should be carefully cleaned. If the latter is much covered by the retouch, it is well to varnish the same similar to the front. The cleaned negative is placed into the printing-frame. The pieces of plate-glass are carefully cleansed, the negative is placed on top of it, and the sensitized paper, perfectly dry, is placed on the negative.

SENSITIZING THE PAPER.

The printing bath should be filtered into a clean glass or porcelain dish. A strip of writing-paper should be drawn several times over the bath to remove the scum; the paper should now be placed on the bath. This work does not require an absolutely dark room, as the paper is not sensitive enough to be influenced much by diffused daylight.

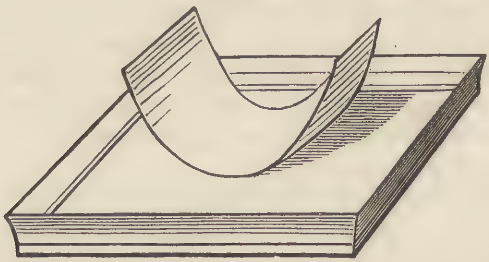
The paper should next be cut into pieces of suitable size (when a large quantity of prints is to be made it is advisable to sensitize whole sheets); the albumen surface should be touched as little as possible in cutting; the paper should be folded with the albumen side upwards, and the fold should be cut from the outside with the scissors. This avoids the soiling of the paper with rust, which is afterwards apt to give rise to black spots. The greatest cleanliness of the tables, on which the silvered and unsilvered paper is placed, cannot be too often recommended.

The paper is placed on the bath by seizing it on two opposite corners; the central part is lowered until it touches the bath, and

* The manufacturer is not always to be blamed, for very often the fault lies with the photographer.

the whole sheet is gradually let down on the liquid. The movement must not be interrupted, as streaks and lines would be the consequence.

FIG. 57.



Air-bubbles under the paper will frequently prevent the proper sensitizing of the paper; to remove them the paper should be lifted by one corner; the bubbles should be removed by a glass rod, and the paper placed on the bath again.

The duration of the floating depends on the strength of the bath, the temperature, the albumen, and it is very variable. In summer three minutes, in winter four minutes, are generally sufficient. A sand-glass is very convenient for timing. *Great care should be taken to prevent the solution from touching the back of the paper, as this invariably gives rise to spots.* When the paper is sensitized it should be carefully removed from the bath by lifting it by one corner, and placed in a dark room to dry. At 77° Fahr. the paper dries very rapidly. When the temperature is low a lamp will often very materially assist in drying, but great care should be taken not to scorch the paper. The dried paper should be examined carefully, as sometimes at the corners, sometimes in the centre, damp spots will be found; these stick to the negative, and many an excellent plate has been ruined by it.

The dried papers should be treated, in regard to handling them, even more carefully than the unsensitized albumen paper. It should be placed into a clean box, and carried in this to the printing-room. A condition for a sharp picture is the intimate contact between negative and paper; this can only be reached by strong pressure. With curved plates we run the risk of breaking them; even with level plates we run this risk, when, as is often the case, glass splinters or grains of sand are present in the copying-frame. The paper should be placed with the sensitive side flat against the negative; a piece of oilcloth should be placed on this; and then a pad, consisting of soft paper or felt, should form the final layer; the

cover is now laid on, the springs are fastened, and the printing may commence.

Some papers curl up in drying, and do not lay smoothly in the printing-frame, particularly when they are too dry, or when the printing is done in a cold room; when this is the case it is well to place the paper, after silvering, in a cool place, or place behind it a piece of cardboard; next open one side of the frame, and draw the paper straight; then open the other half of the frame, and draw the other side straight. The frame should not be exposed to the light until we feel fully convinced that the contact is perfect.

The fuming with ammonia is in almost universal use in the United States. It has the advantage, that a diluted bath (1 salt of silver and 20 water) will work well, and yield good pictures. Fumed paper will also print more rapidly. In the dry atmosphere of many parts of the United States the fuming with ammonia has the other advantage, that a certain amount of moisture is imparted to the paper. The dry silvered paper is placed, for from ten minutes to half an hour, in a closet, on the bottom of which a dish with ammonia has been placed.

In Europe we employ the fuming process very seldom.

THE PRINTING.

When all the frames have been supplied with paper they are placed in the light. They should be so arranged that plates of equal density are placed together. It will then only be necessary to examine one frame from time to time, and from the result we can judge of the rest.

The exposure is much longer than when making the negative. With dense positives, and dark or cloudy weather, it may take days, and sometimes the paper will turn yellow before the print is finished. A tolerably good judgment can be formed, by watching the edges of the paper which protrude from under the negative; these become bronzed, and the negative picture commences to show as a positive. But to be perfectly informed in regard to the progress of the work the prints should be examined from time to time; the frame is taken into the room, and in a place that is not too light, one-half of the back is opened, the print is examined, the lid is closed again, and now the other half is examined in the same manner. *Care should be taken not to move the paper, in order that on closing the lid it will resume its original position.*

The print is finished when the finest details in the high lights

have become visible, when the protruding corners have become bronzed, and when the intensity of the whole print is a little in excess of what is desired in the finished picture.

The latter is necessary, because some intensity is always lost in toning. Experience only can determine the proper degree to which printing may be carried; it depends also on the character of the negative, and the kind of gold bath that is to be used.

PRINTING VIGNETTES.

To produce pictures in which the background gradually changes from dark to white, it is necessary to cover the negative with a vignette frame. This consists sometimes of a glass plate which is bright in the centre, and becomes gradually darker towards the margin, or simply of a piece of pasteboard, in which a hole has been cut corresponding with the figure on the negative. This piece of pasteboard is placed on the printing-frame. By removing it further from the negative the gradation of tone will become more gentle and gradual, but the pictures print also slower.

Care should be taken that the pasteboard does not change its position; side-light also should be excluded, as it may give rise to undesirable discolorations. It is best to nail the pasteboard on to the printing-frame. When large quantities of prints are to be made, vignette-frames of sheet-iron are advantageous. When white pasteboard is used, it should be blackened. Vignetting is of great advantage when the background is faulty.

PRINTING OF IMPERFECT NEGATIVES.

The printing rules which we have given will suffice for a perfect negative, which has brilliant but not too dense lights, and shows details in the shadows. But we frequently have weak negatives, in which all the details in the lights have made their appearance before the shadows have gained sufficient strength.

These are best printed under a piece of green glass. Experience has taught us that with a feeble light the contrasts become stronger, or, what is the same, the shadows become darker and the lights brighter.

Another way is to cover the back of the negative with varnish in which a little dragon's blood has been dissolved. This varnish will weaken the light similar to the green glass. On the other hand, we may have strong hard negatives, in which the shadows would be completely burned up, if we would print until the details appear

in the lights. We can then help ourselves by covering the black surfaces when they have reached sufficient density, by suitably cut pieces of pasteboard (masks). Small portions of the lights, that are too dense to print properly, can be brought out by condensing light on them with a lens.

THE WASHING.

The prints are taken from the frames and placed in a dark-box; but not in the same one in which the sensitized papers are kept. When all the prints are finished, they should be treated in the following manner:

To keep prints till the following day is only advisable when we are sure that the paper will not turn yellow.

The paper absorbs from the bath a considerable quantity of nitrate of silver; of this only the smallest portion is reduced by the light, and in the printed picture a considerable quantity of free nitrate of silver remains. By decomposing the gold this substance would act very injuriously on the toning bath if it were permitted to remain.* The nitrate is removed by washing. Gutta-percha dishes will answer for this purpose; they are less liable to breakage than porcelain or glass dishes. *It should, however, be a rule to use these dishes for no other purposes, and the washing should be done on a table where an admixture with other chemicals, particularly hyposulphite of soda, is not to be feared.* The sheets are placed, one after the other, with *perfectly clean fingers*, into a dish which is filled with clean water; each sheet should be perfectly wetted; generally the water turns milky in consequence of the separation of chloride of silver. After ten minutes the prints are removed from the first dish into a second one, and the milky liquid is poured in the barrel for silver residues. The same is done with the water of the second dish. When they have been washed in five or six changes of water, or when the water no longer appears milky, the washing may be considered complete. It is not worth the trouble to save the water from the last two washings. The washing should be done in a dimly lit room, otherwise the whites may suffer.

THE TONING.

The picture should be toned as soon as the washing is finished.†

* When nitrate of silver is mixed with chloride of gold, chloride of silver and metallic gold will be formed, and oxygen and nitric acid will become free.

† Pictures which remain for a long time in water (say about twelve hours) often suffer decomposition and tone unevenly.

The toning bath should be placed in a dish which is solely devoted to this purpose; the bath should be warmed a little in winter-time. One print after another should be immersed in the bath, with clean fingers, and while agitating the bath constantly. It is necessary that the gold solution wets the pictures equally, otherwise unequal toning will be the consequence. The change of color in the pictures is readily noticed; soon after immersion they assume a brownish violet tint, they next turn violet, violet blue, and finally blue or slate color. As soon as the desired tone has been reached (violet or violet blue is probably the most generally liked), the pictures are taken from the bath and thrown into a dish of water. The toning should also be done in a semi-dark room, otherwise the whites may suffer. Daylight is better than lamplight (but when we are compelled to use lamplight, the lamp should be placed as close as possible to the dish). The most practical way is to place three dishes alongside of each other. To the left a dish with the pictures in water, in the centre the gold bath, and to the right another dish with water. No more pictures should be thrown into the bath at once than what we are able to control, otherwise we run the risk of overtoning. Pictures on plain paper tone more rapidly than those on albumen paper. For the former a very dilute gold bath, or one which has been partially exhausted by being previously employed for albumen prints, should be used.

THE FIXING.

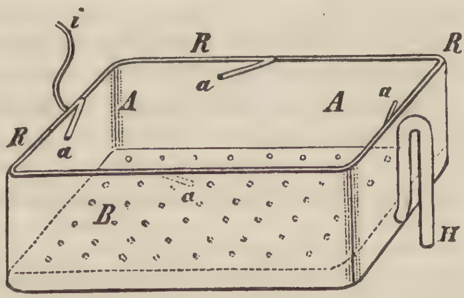
The fixing should be done in a dish especially devoted to that purpose. One by one the prints are taken from the water and placed into the fixing solution. The dish should be moved in order that the liquid may flow at once over the print. Great care must be taken to keep the fingers free from soda solution, as a toned print, which has been handled with "soda fingers" previous to fixing, will invariably show spots. Many use wooden forceps for "handling" the unfixed prints.

The pictures assume an unpleasant tone in the soda bath, very brown when the time allowed for toning has been very short, at the same time they become paler. Beginners must not be deceived by this. The tone improves after washing and drying, and finally *the intensity becomes the same which the pictures showed in the toning bath.* The latter can be used as a guide. The duration of the fixing process is at least five minutes. Until the fixing process is finished the whites in the pictures will appear mottled or cloudy.

THE WASHING AFTER FIXING.

In the fixed picture a considerable quantity of hyposulphite of soda remains. If this substance were permitted to stay in the paper, decomposition would soon take place; the sulphur would combine with the silver, forming sulphate of silver, and the print would turn yellow. The thorough washing, the perfect removal of hyposulphite of soda, is hence very necessary. The simplest way to accomplish it is by using frequent changes of water. For an atelier the following can be recommended. *A* (Fig. 58) is a cistern of Japanned tin, with a double bottom; the upper one, *B*, is perforated with holes, like a sieve; *H* is a syphon with its opening at the lowest place of the box; *R* is a pipe, either provided with small openings, or tubes, *a*, *a*, *a*, *a;* this pipe is connected with the water supply pipes, or with a reservoir; the size of the syphon, *H*, should be selected sufficiently large, or of such a diameter, that the box is twice as rapidly emptied of its contents, as the pipe *R* is capable of filling it. The fixed pictures are first placed in a dish with clean water. The vessel, *A*, is now filled with water, and the pictures are placed in it one by one while the water is soon flowing; as the vessel is filled to the top line of the syphon, the latter commences to act, and in spite of the constant addition through the pipe, *R*, empties the box in a few minutes; as soon as this is done its action ceases. The vessel is filled again with water, and the process repeats itself. By such an arrangement it is possible to wash pictures perfectly in from one to two hours, according to quantity; *care should be taken that the prints do not stick together;* when this takes place soda is apt to remain in the paper in spite of

FIG. 58.



repeated washings. To avoid this sticking together, a rotary motion is given to the water by placing the supply tubes, *a*, *a*, *a*, in an oblique direction, as shown in the figure. The pictures will float

in the direction of the current, and when the size of the prints is not large, this arrangement will answer. But when we have large prints, personal inspection from time to time, and removal by hand is necessary; the washing should also be continued as long as possible.

In large establishments the prints are generally washed for a whole night.

Mr. Schade, in Sorau, recommends a constant tilting of the wash-box by an electro-magnetic arrangement.

Sometimes the prints will stick to the sides of the box; to prevent this small holes are made into the lower side of the pipe, *R*, and the water which runs down on the sides of the box will remove the prints which stick to them.

To ascertain if the washing has been carried far enough, the iodine starch test of the author is employed. When the washing is finished, the pictures are separated under water, and a portion of the last water is taken from the box. For the purpose of testing, two test-tubes of equal size, and perfectly clean, should be selected; in each an equal quantity of a solution of iodide of starch* should be filled; to the one tube fresh water from the reservoir is added; to the other an equal quantity from the last water in the wash-box. It remains only necessary to shake both tubes well, and to hold them against a piece of white paper in order to ascertain if in one of the tubes a discoloration has taken place. The greatest cleanliness of the hands and test-tubes is necessary. Even with a millionfold dilution, the presence of soda can be detected. When the test shows that soda, or even a trace of it, is still present, the washing should be repeated. When we wish to test finished pictures by this method, we must soak them first in water, and then test the water as described above. The washed pictures are dried, hung back to back on clean cords in a place free from dust.

Some operators place the prints between blotting-papers; here it sometimes happens that with imperfect washing the blotting-paper becomes gradually saturated with the soda and causes yellow

* Iodide of starch is made as follows: 1 grain arrowroot is mixed with a few drops of cold water; next about 100 parts of distilled boiling water are poured on it, and afterwards 20 parts of chemically pure saltpetre are added to make the paste keep. To the solution of starch 20 grains of a wine-yellow solution of iodine in iodide of potassium solution is added (a bit of iodine thrown into a solution of iodide of potassium, 1 : 20, will furnish this in a few seconds). This will give a blue solution of iodide of starch which will keep for about four weeks.

spots on the pictures. Frequently fresh blotting-paper contains soda, as this substance is often added to the paper pulp after bleaching. To test paper for soda, the above described solution of iodide of starch should be dropped upon it. A discoloration will indicate at once the presence of soda. At any rate the drying-paper should be changed very frequently.

THE FINISHING.

The dried pictures are cut to the proper shape; it is best to use a sharp steel knife, a glass table, and glass ruler or form. Right angled and round or oval guides are used; very seldom oblique angles. This will easily be understood by drawing a straight line, *a b*, when we erect on it with the guide a vertical line, *c d*, and when we place the guide* to the right and left of *c d*, it has to fit exactly. With smaller sizes, as, for instance, cartes de visite, a glass plate of the exact proportions is often used to cut by. The cut pictures are pasted on Bristol-board to give them more firmness. The "mount" very often contains soda; in doubtful cases a test for soda should be made with iodide of starch in the manner described above.

The board may be either sized or not; the latter are sometimes preferred on account of cheapness, when great quantities of prints have to be furnished. The pictures are pasted very easily, but have the disadvantage that they will draw a great deal in drying; this can be avoided by carefully dampening the back of the mount previous to pasting the print on it.

Very often the mounts are tinted; pale colors should be selected; care should also be taken that the signatures, and other printed matter, does not contrast too glaringly. When the tint is laid on too heavy it is an impediment to pasting. As a mounting medium common paste is most generally used. It should always be used fresh, and the addition of salts, as for instance alum, should be avoided; such addition frequently spoils the pictures.

An addition of alcohol to the paste is said to prevent the latter from turning sour. It is necessary that the paste be perfectly homogeneous. It should be stirred, and afterwards, while still hot, squeezed through a cloth or fine muslin. Mounting requires practice, but the necessary skill is easily acquired. Many operators use a solution of gelatine for mounting, but I do not find it as convenient as common paste. The mounted pictures are left to

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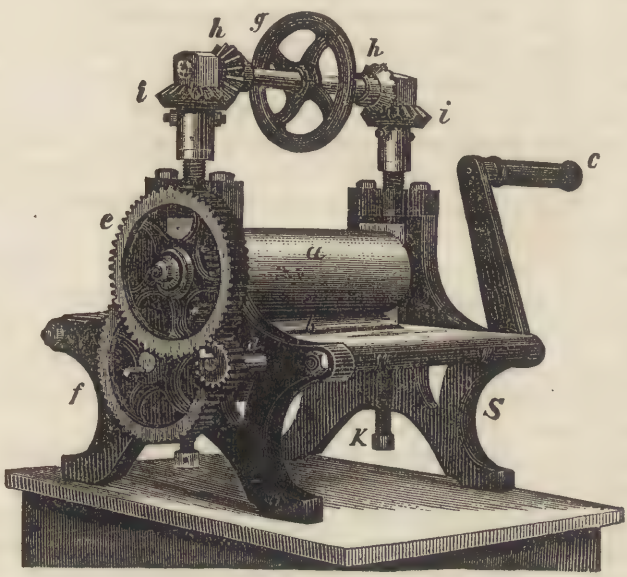
* By a guide a "right angle," L, is meant.—TRANSLATOR.

dry. When the mounts have not been sized it is best to place them between blotting-papers and boards, as it facilitates the rolling. The rolling gives smoothness to the pictures. The rolling presses used for this purpose are generally imperfect in construction. The price is so low that little can be expected.

The press consists of a steel plate* (Fig. 59), on which the mounted picture with the picture side downwards is placed; it is pushed between parallel cylinders *a*, *b*; parallelism is secured by the screws *K*. Before placing the plate between the rollers the adjustment is carefully made by examining the distance with the eye. The plate is now placed in position, the rollers are screwed

Fig. 59.



together by turning the wheel *g*, and plate and cylinders are carefully cleaned. To ascertain if everything is clean and in good working order a piece of white Bristol board is passed through. The pictures are placed on the plate perfectly dry, otherwise they will stick. The retouches should be laid on before rolling. For small sized pictures, small presses with smooth rollers and without a plate have been made; they are very convenient.

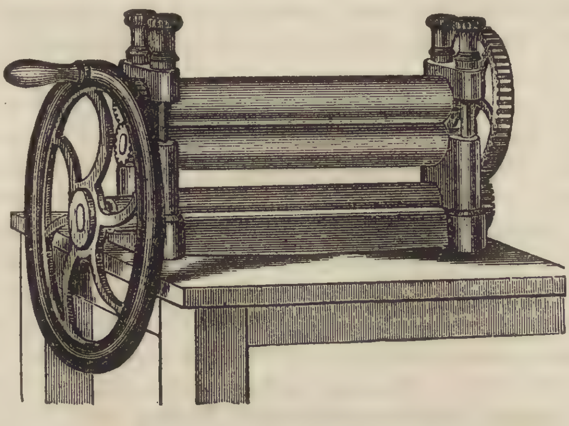
Large pictures should be as smooth as possible previous to being

* In order to show the cylinder and cogwheels the plate has been omitted in the illustration.

placed in the press; a slight moistening of the mount previous to placing the picture on it, and drying between blotting-paper under pressure, will secure this result.

In the Excelsior Press of the Scovill Manufacturing Company, N. Y., which is in common use in America, the steel plate is dispensed with. This reduces the cost very much, and makes a very desirable press. The gearing shown in the figure below makes the adjustment very easy, and it is a very good press.

FIG. 59 *a*.



After the pictures have been rolled, many photographers give them a lustre by waxing. The common cerate is used for this purpose; a small quantity is placed on the picture, and well rubbed in with a small piece of woollen cloth. The depths become more prominent, the whole picture appears more brilliant, the retouch becomes invisible, and moisture is excluded.

CARE OF THE UTENSILS AND CHEMICALS IN THE POSITIVE PROCESS.

Care of the Negative.

Negatives are the photographic printing plates, and the photographer has to bestow care on their preservation in proportion to the number of prints which he expects to take from them; this becomes the more difficult, as on the one hand the material is the most fragile in existence; on the other hand the printing surface, *i.e.*, the *varnished collodion film*, offers, when compared with a lithographic stone or a copper-plate, a very soft and easily injured surface. When we add to this the almost indispensable negative retouch, which, in the shape of India ink or oil paint, is placed on the glass or on the varnished surface, and which can be rubbed off

with the finger; and when we consider further, that for the prints a paper is used, impregnated with one of the most caustic substances —nitrate of silver—which, of course, exercises its influence on the varnish, we cannot help feeling surprised that a negative actually lasts as long as it does. Let any one touch a negative, from which a dozen prints have been made, with the point of the tongue, and he will be surprised how strongly it tastes of nitrate of silver.

This circumstance alone indicates chemical changes in the negative during printing. The silver salt is partly absorbed by the varnish, the latter becomes colored by the light—generally yellowish—and, with a large edition, the last prints appear harder than the first impressions.

With a weak negative this may sometimes be an advantage. Another change, but a much more dangerous one, is caused by moisture. Mr. Stiehm communicated to the "Mittheilungen" the result of an experiment which showed, in a characteristic manner, the influence of moisture. He placed damp blotting-paper on a negative, and twelve hours afterwards it showed cracks. These cracks, unfortunately, appear too often on their own account, and spoil many a beautiful negative. They happen most frequently with plate-glasses, and we once heard the remark that they only happen with them. My experience teaches me, however, that other glass is equally liable to this fatality, although not so frequently, and I feel convinced that moisture is the main cause of its origin. It has happened to me, that of a number of negatives, which were made at the same time and under similar circumstances, some, which had been handed to the printer, became cracked, while the others, which remained undisturbed in the closet, showed no such tendency. And here the fact established itself that a negative which had been kept in a very damp place showed this tendency soonest; and, further, that gross carelessness of the printer, who had employed imperfectly dried paper, caused the balance of the injury. Too much license is given to the printer. In no place is strict surveillance more necessary than here; they hold in their possession the treasure of the photographer, and how do they treat it? I have noticed myself that in printing-frames, which were removed at the beginning of a shower, the pad at the back of the negative had become moistened, and still the printer did not consider it worth his while to replace it by a dry one.

The consequences of such carelessness are easily imagined. They may not manifest themselves at once, but after the twentieth or fortieth impression the varnish will show cracks. Most pro-

prietors have no idea how many negatives are totally destroyed by grains of sand insinuating themselves into the printing-frame; or how many films are scratched by careless handling.

These circumstances explain the variable permanency of the negatives in our galleries.

Some photographers preserve their negatives in plate boxes; this method can only be recommended when the boxes are made of dry and well-varnished wood. It is much better to keep them in airy closets in a dry room, and I consider it as advantageous that the closets are removed a little from the wall, so as to permit a current of air to circulate around them.

I have noticed that leakage in the roof admitted water into the negative storeroom; it manifested itself as a damp streak along the wall, which, while covered by the closet containing the negatives, was not noticed until finally the moisture penetrated through the wooden partition of the closet, and became visible. The result was that some valuable negatives were lost by cracking of the film. I must also mention another characteristic circumstance. The author noticed that the plates which were made in the moist climate of Aden showed an exceedingly tender film, while, on the other hand, those that were taken in the desert showed no such delicacy. In the production of the negative, moisture plays an important role as regards permanency. The author's experience leads him to reject a caoutchouc solution previous to varnishing as unreliable; on the contrary, it makes the film more tender.

It has been recommended to treat the negative to a solution of gum Arabic, 1 : 30, previous to varnishing. But such plates are not insured against cracking either.

The restoration of cracked negatives offers other difficulties; the method which has frequently been suggested, of exposing the film to the vapors of alcohol and ether, by placing it on a dish containing these two fluids, has been frequently recommended; but it is not always successful. The cracks do not always bear the same character; many of them are thrown up, like the burrows of a mole.

The latter will disappear almost completely when we place the negative over a dish containing a little alcohol. The varnish becomes soft in twenty-four hours, and the outlines of the cracks coalesce.

The negative is warmed afterwards in order to harden the varnish.

Another kind of cracks are the so-called hard lines; they are not elevated, but depressed; they can be partially removed by rubbing

them over with gray silver powder (silver precipitated by sulphate of iron).

Some will disappear by pressure with the finger-nails; but the vapors of alcohol will not obliterate them. Warming of the plate will sometimes remove them completely; but unfortunately they will reappear after a while.

Under such circumstances a process which *enables us to multiply negatives* becomes for the photographer absolutely invaluable. We will consider such a method in one of the subsequent chapters.

THE CARE OF THE PAPER.

The photographic paper, which is stored in a dry place, will keep for a considerable period. It seems almost as if albumen paper, which has been on hand for some time, would give better results than fresh paper.

In the albumen film itself changes take place in course of time; gases are developed, and, sometimes, the products of decomposition may affect the process injuriously. It is, for instance, an established fact that good albumen paper, which had been sent to America in soldered tin boxes, on its arrival proved worthless; but after being exposed to the air for some time it yielded good results. This circumstance seems to make the keeping of albumen-paper in an airy room advisable.

Another circumstance which influences the paper very much, is the state of dryness of the albumen surface.

When the latter is very dry, for instance, in the heat of the summer, we notice that the paper repels the bath as if it was greasy, and the paper becomes covered with blisters; when placed in the wash-water, on leaving the fixing solution, these blisters sometimes disappear again, and at other times they break and spoil the picture.

They can be avoided by placing the paper twenty-four hours before use in a damp cool place, a cellar, for instance.

If blisters still make their appearance, the paper should not be placed in water at once after leaving the fixing solution, but should be immersed in a solution of hypo twice as weak as the fixing bath, next in one four times as weak, and finally washed in water.

The above-mentioned facts demonstrate that the paper should possess a certain degree of moisture in order to secure good results.

This refers to silvered paper also. When we place silvered paper in a box with chloride of calcium, the latter will deprive it of all its moisture; it will keep white for a long time, but it will fail to give satisfactory results.

The turning yellow of silvered paper is an evil which in summer-time gives much trouble to the photographer; it shows itself particularly with papers that have been made with old and fermented albumen; the yellow color disappears in the gold and fixing baths partly, particularly when we add to the latter a one-thousandth part of cyanide of potassium. Still pictures taken on such paper lack brilliancy.

THE CARE OF THE POSITIVE SILVER BATH.

The positive bath is not liable to near as many accidents as the negative bath. Microscopic quantities of organic substances or acids will affect the latter to some extent, and sometimes make it useless. The positive bath is not affected by impurities in such small quantities. It is evident that the impurities must increase with every additional sheet of paper, as the nitrates which are formed by double decomposition pass into it; still they do not seem to hurt, but on the contrary exert a beneficial influence, as the absorption of silver from an old bath is less than from a new one.

Organic impurities also pass from the paper into the bath. The condition of the albumen used on the paper is quite variable; on some papers it is laid on fresh, while in other cases it is first subjected to fermentation. Its chemical properties are not the same, and so it happens that some papers impart so much organic matter to the bath that after a few sheets have been silvered it will turn brown. In this state it is unfit for use, as the paper cannot be evenly sensitized upon it.

Fortunately we possess in the permanganate of potash a remedy which will restore a bath so discolored instantly.

The method is the same as described above, when speaking of the negative bath.

Formerly a bath which had turned brown, was exposed to sunlight; this led to the same result, but the process was much slower.

Besides its strength, we have to consider the reaction of the bath. A neutral bath is in the most favorable condition.

But it happens frequently that a bath, which is neutral when new, turns gradually acid, when the albumen-paper has an acid reaction; in this case the bath is apt to turn brown, and the pictures are gray and weak. Testing with litmus paper, and the addition of a little solution of soda, will easily remedy this. To keep a bath neutral, the addition of the carbonate of the oxide of silver is very good; it is put into the stock-bottle; it is easily made by adding a little carbonate of soda to the bath. Some papers will stand an

alkaline silver bath without detriment; these papers generally contain a certain quantity of free acid.

Some manufacturers intentionally add organic acids to the albumen, for instance, citric acid; it produces a more reddish tone, and keeps the silvered surface white for a longer time.

I do not think that such additions are advisable. A portion of the acid enters the bath, and seems to impart to it a red color under certain circumstances.

A bath with an alkaline reaction sometimes attacks a film which is easily soluble. A weak acid, such as acetic acid,* is the best for neutralizing it.

Another change in the bath is produced by the loss of the silver salt.

With a very strong bath (12½ per cent. and more) this circumstance does not amount to much, for even when the amount of silver has been reduced as low as 5 per cent., the bath will work well, *provided the paper is of good quality.*

Otherwise the deficiency of silver soon manifests itself by the *weakness of the prints.* The shadows do not appear vigorous; the lights are gray, and the picture is monotonous; sometimes it will cause the *peeling of the albumen film.* It is therefore absolutely necessary that the bath should be tested from time to time, and fresh silver salt added according to circumstances.

For this purpose instruments called hydrometers are used; they are placed in the bath and sink into the liquid according to the specific gravity of the same; they are provided with a scale divided in degrees, and by noticing the degree indicated by the surface line of the liquid in which the hydrometer floats, the percentage of silver salt contained in it can be ascertained by consulting a properly prepared table in which the degrees of the hydrometer are converted into per cents of silver.

If the indications of this instrument were reliable but little objection could be raised against its use; but it is well known that the indications are influenced in the highest degree by the presence of alcohol, ether, acetic acid, and different salts, to such an extent that the test not only becomes useless, but even worse, because the wrong indications mislead, deceive, and produce errors of the most fatal kind. These experiences make the introduction of a reliable silver tester a necessity.

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* According to a statement by Mr. England, a brown bath is restored by boiling it from 10 to 15 minutes. The organic matter separates with a part of the silver.

Gay Lussac gave us such a method in the so-called triturating process with chloride of sodium. A solution of chloride of sodium of a given strength is added to a silver solution until no further precipitate of chloride of silver takes place. The quantity of the chloride of sodium solution necessary to precipitate all the silver determines the quantity of the latter. Unfortunately this method has a drawback; the cloudy appearance of the liquid makes it very difficult to ascertain the precise moment when the precipitation of chloride of silver ceases. The following method of the author is free from this error.

This method is based on the peculiar action of iodide of potassium on solutions of nitrate of silver on the one hand, and nitric acid on the other hand. When iodide of potassium is added to a solution of nitrate of silver, a precipitate of yellow iodide of silver will be formed; when iodide of potassium is added to a thin solution of starch paste and nitric acid, *containing a small quantity of nitrous acid*, iodine will at once be set free, which imparts to all of the liquid a deep blue color.

When we add a solution of iodide of potassium to a mixture of the solutions of nitrate of silver, nitric acid, and starch, the two processes will take place simultaneously; iodide of silver will be formed as a precipitate, and free iodine, which in the presence of starch paste imparts to the liquid a *blue* color. But so long as a free salt of silver is present in the solution, this blue color will disappear at once on agitation, and the liquid will assume a pure yellow color. When we continue to add the solution of iodide of potassium drop by drop, we will soon arrive at a point where the blue color no longer disappears on shaking the liquid, but remains permanent; this indicates that *all the free salt of silver has been precipitated*, and from the quantity of iodide of potassium solution which was necessary to produce this result, it is easy to determine the quantity of silver which has been precipitated. The point when all the silver has been precipitated is ascertained by the blue color, with *surprising exactness;* a single drop of iodide of potassium in excess suffices to give to all the liquid an intense and permanent blue color. (When iodide of silver is present in large quantities the color will be more green than blue.)

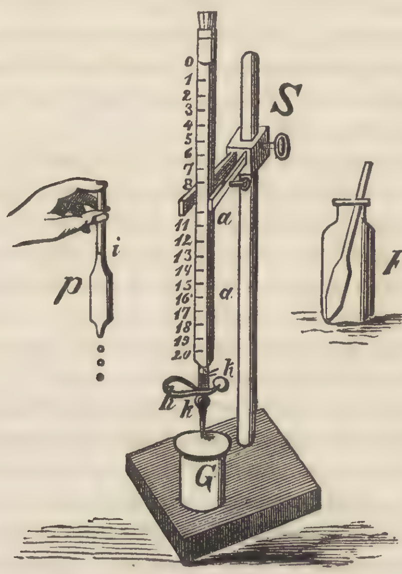
To employ this method practically, a solution of iodide of potassium, which contains in 1023.4 cubic centimetres exactly 10 grammes chemically pure dried iodide of potassium, is prepared. One hundred cubic centimetres of this solution will precipitate exactly 1 gramme of nitrate of silver; hence, when we take for a test

1 cubic centimetre of silver solution, each cubic centimetre of iodide of potassium solution will indicate one per cent. of silver salt.

This solution is carefully poured into a Mohr's spring compressor burette,* avoiding air-bubbles (the burette is divided in $\frac{1}{5}$ cubic centimetres). The burette is placed into the holder, *S*; the spring compressor, *h*, is opened by pressing the button, *k*, and the liquid is allowed to run out until the lower curve of the surface of the liquid touches the point 0 (zero). It is necessary that the spring should at first be opened to the full extent, in order to expel the air and old solution which may have collected in the lower part of the tube. This must not be overlooked.

When this has been done, the cleaned and dried pipette, *p*, is

FIG. 60.



dipped into the solution of silver which is to be tested;† the air is sucked out with the mouth, and when the tube is nearly filled, the upper opening is quickly closed with the dry index finger; the pipette is taken out of the solution, and by lifting the finger gently

* These spring compressors are very convenient; the operator can at his pleasure allow the liquid to run out drop by drop or in a stream.

† It is self-evident that the pipette must be perfectly clean and free from old solution, otherwise it would mix with the new solution and change its character. In practice it is sufficient to fill the pipette, empty the contents, and fill it again; by repeating this operation twice or three times, the solution will be clean enough for all practical purposes.

the fluid is allowed to run out until it reaches the point *i*. The lower end of the pipette, which holds now exactly one cubic centimetre, is held against the side of the glass *G;* the fluid is forced into the glass by blowing in the upper end of the pipette. Instead of the glass a test-tube may be used; the latter is more convenient for shaking. (The small remnant of the fluid which may remain in the point of the pipette is of no account.)

With a second similar pipette, about 1 or 2 cubic centimetres of nitric acid are taken from the bottle *F;* for strong solutions a little more; for weak ones somewhat less.

The contents of this pipette are also emptied into the glass *G*, in the manner described above, and finally 10 to 15 drops of starch solution are added. Now the test may commence. The burette should be examined once more, to see that the exact quantity of fluid is contained in it. The glass is lifted up high with the left hand. The spring compressor is opened carefully, and a few drops are allowed to flow into the glass; when the silver solution is strong, a yellow precipitate will be formed at first, which will afterwards change to blue; when the solution of silver is weak, the blue color will show itself at once, but will disappear again on shaking the glass. In the former case, the iodide of potassium solution may be added more freely; in the latter case more caution should be exercised. The glass, *a*, should be constantly shaken to mix the fluid thoroughly.

Finally the blue color will disappear more slowly; great care is now necessary, as a single drop may suffice to produce a blue or green color, which will not disappear again on shaking. The spring compressor is now closed, and the height of the fluid is read off the scale; when this indicates, for instance, $7\frac{3}{5}$; then the silver solution contains $7\frac{3}{5}$ per cent., or in 100 cubic centimetres $7\frac{3}{5}$ grammes of silver. It is not at all difficult to observe one-tenth of one per cent. on the scale. Those who are not accustomed to work with burette and pipette will handle them at first rather awkwardly; but a little practice will soon give them the necessary confidence.

With strong silver solutions it is advisable to add, near the close of the operation, a few drops of starch solution, particularly when the color is not very decided; with brown positive baths the color is always somewhat dirty; still, with a little extra care, the determination is not difficult.*

* For strong solutions (positive bath) one-half cubic centimetre is sufficient for a trial. But the degrees of the burette which are obtained must be multiplied by two.

When with pure silver solutions the blue color appears dirty at the start, or not at all, then the starch paste is spoiled, or the nitric acid does not act. The former is easily made again; the latter will act when a few pieces of sulphate of iron are added (see below). If the operation should fail from the above reasons, or from want of skill of the operator, it is very easy to repeat it.

The burette and the iodide of potassium solution should be closed with well-fitting corks when not in use. A pound of iodide of potassium solution will, according to the strength of the solutions to be tested, suffice for from 30 to 50 tests.

Starch paste is made by boiling about 25 cubic centimetres of distilled water, and adding to it $1\frac{1}{2}$ grammes of arrowroot flour. *Before using it the paste must be cooled in cold water.*

The prepared nitric acid is also easily made by adding to two ounces of chemically pure nitric acid one grain of sulphate of iron. In the presence of the salts of copper, salts of mercury, or hyposulphite of soda, this test is not applicable. In photographic practice, the latter substance only is likely to interfere.

The above-described apparatus is known as Vogel's Silver Tester; for sale by the stockdealers.

THE CARE OF THE SENSITIZED PAPER.

It is a general complaint amongst photographers that some papers turn yellow very rapidly after they have been sensitized. A positive remedy for this evil has not been found as yet, but it is certain that it can be partially obviated.

1. By keeping the paper in a very dry place. Drying boxes and tin cases with chloride of calcium have been recommended; but I must caution against their use; they preserve the paper, but the paper prints badly; the cause of it is that the printing process—which is a chemical decomposition—can only take place in a normal manner in the presence of a certain quantity of moisture.

2. By placing at the back of the sensitive paper, in the printing-frame, a piece of *waxed paper*. In the printing process, gases are developed which exercise a reducing influence; these are absorbed by the pad (consisting generally of felt or blotting-paper), and cause the paper to turn yellow rapidly. A piece of wax paper will prevent this.

3. In order to make the silvered albumen paper more permanent, it has been recommended to sensitize it on a bath containing sugar.

Simpson recommends to a 200 gramme bath, 1 : 12, 1 to 3 grammes of sugar. It is said the paper will keep white for months.

Ost recommends, for the same purpose, the addition of citric acid.

He uses the following bath:

Nitrate of silver, ...	1 part.
Water, ...	12 "
Citric acid, ...	1 "
Alcohol, ...	1 "

4. Mr. Baden writes, that when ordinary albumen paper is washed, *after it has been silvered*, and all the free nitrate of silver is removed, it will keep white for a long time, and by fuming it with ammonia, it can be made as sensitive as carbonate of silver paper.

The author has tried this process and found that it worked excellently.

CARE OF THE TONING BATH.

The toning bath is not very permanent; this is owing to the unstableness of the salts of gold. Alkaline toning baths must always be made fresh immediately previous to using them. Acid toning baths, and those containing rhodan gold, will keep longer; they should be strengthened from time to time. But here also a freshly made bath is preferable.

The residues of the toning bath are filled in large bottles or jars, and from time to time a little solution of sulphate of iron and hydrochloric acid are added; the gold is precipitated in the form of a brown powder, and can be collected and reconverted into chloride of gold.

This process is not adapted to rhodan gold baths or those containing hyposulphite of soda.

THE CARE OF THE FIXING BATH.

The fixing bath does not keep well; it should be frequently renewed, as with prolonged use decomposition will take place, and sulphate of silver is formed, which causes the prints to turn yellow.

B. THE CARBON PRINTING PROCESS.

To the description of the silver printing process we will add the process for making carbon, or rather pigment pictures.

They have only recently been made in large quantities. As regards their ability to resist chemical influences, and also the

choice of color (the maker can give to the gelatine film, which is the foundation of the picture, any color he chooses to take) they offer considerable advantages over the silver prints, which advantages would perhaps make themselves still more felt, if the process was less complicated.

I suppose that the principle of the process is known, and proceed at once to a description of the mode of printing, as first practically introduced by Mr. Swan in Newcastle, and simplified by the author of this book. Its peculiarity consists in the production of a film of gelatine, on which by exposure an invisible picture, insoluble in hot water, is formed; the picture becomes visible by dissolving with hot water those parts of the film which have been protected against the light. But as in this washing operation the delicate parts of the print are apt to be injured or swept away, it is necessary to transfer the gelatine film previous to the "development" to another surface, and as this produces a reversed picture a second transferring becomes necessary.

Pigment paper is the material upon which the prints are made. It is a paper coated with colored gelatine, and can be bought of the stockdealers; two kinds are mostly used, the so-called *purple black* and purple brown. It should be kept in a place which is neither damp nor too dry. In a very dry place the *gelatine film is apt to break.*

Sensitizing of the Paper.—The sheet which is to be sensitized is placed upon a glass plate, and the printing surface is gently rubbed with a soft clean linen cloth. It should be avoided as much as possible to touch the paper with the hands or fingers.* After being cleaned it is seized by two corners, and dipped into the sensitizing solution, and by drawing it through it it is skilfully turned, and left in it for three or four minutes with the printing surface uppermost. This must be done by *lamplight.* The sensitizing solution consists of—

30 parts bichromate of potash.
900 parts cold water.

The solution will not keep for a long time, and it is best not to make more than what is necessary for immediate use. For a sheet of pigment paper about 250 cubic centimetres of solution are necessary. The solution is thrown away after being used. The necessary temperature is about 66° Fahr. Two pieces of paper can be placed at once into the solution, but they must be kept sepa-

* With fresh clean sheets the rubbing is unnecessary.

rated. When deep boxes are used the paper can be placed in them vertically, and a larger number can be sensitized at once, but they must be kept about one-half of an inch apart. When the paper has been taken out of the bath it is hung up to dry, by fastening two corners to strings stretched in the dark-room. The drying temperature must not exceed 78° Fahr.; when it is higher the gelatine is apt to run off. In this case it would be better to place the sheets on nearly horizontal boards. The drying requires from six to twelve hours. Paper which has been sensitized in the evening is ready for printing the next morning. In dry weather the paper will keep for several days, in damp weather only twenty-four hours. It is best to place the sensitized paper into a book with a weight on it; it must, of course, be kept in the dark.

Exposure of the Paper.—To make a print, the perfectly dry paper is placed with the negative into the printing-frame, always, of course, by lamplight.

The exposure was formerly the most difficult part, but the introduction of the photometer has surmounted this difficulty, and made it even more simple than the silver process, as not all the frames, but only the photometer, has to be examined. A person not experienced in the use of the photometer will do well to make some trials with it before printing a picture (see below, page 170).

Gumming.—The exposed paper does not show a trace of the picture. It looks as black as before. The picture appears only after immersion in hot water. If this were done at once a picture without half-tones would be the result (see above). To avoid this the gelatine film is transferred to another paper in the following manner: After exposure, the corners of the picture are fastened with clamps to a plate of glass; this is done by lamplight; the printing surface must be uppermost. The surface is next coated with an even layer of caoutchouc solution, applying it with a camel's-hair brush; the picture is now hung up to dry. Care should be taken that no part of the solution insinuates itself between the glass and the paper, or touches the under side of the paper, as this sometimes will spoil the picture. After about a quarter of an hour the "gummed" pictures are dry and ready to be mounted on the caoutchouc paper.

Mounting.—The gummed sheet of pigment paper is placed with the gummed side upon a sheet of caoutchouc paper which has been spread upon a smooth table. The paper is pressed from the centre towards the margin to exclude air-bubbles. This operation requires great care. It is best to bring first one edge of the caout-

chouc paper in contact with one edge of the gummed paper; when both margins have been smoothly joined together by passing over them with the finger-nail, the balance of the sheet of pigment paper which has been held suspended is gradually lowered and pressed into contact. When this operation produces a fold the sheet of pigment paper can be drawn off, and when it has been re-gummed and dried the operation may be repeated.

Suitable caoutchouc paper and caoutchouc solution are for sale by the stockdealers.

It must be observed that the two surfaces will only stick together when the caoutchouc film is perfectly dry.

The margins of the two papers are now trimmed with a large pair of scissors in such a manner that the margin of the caoutchouc paper protrudes a quarter of an inch.

The two papers are placed on the plate of a good rolling press, the caoutchouc paper being uppermost; on the top of the latter a piece of felt is laid, and on this again a piece of pasteboard; the whole is now passed through the press.

The pressure of the press should be very strong; for larger sizes it must be increased in proportion. Passing it through the press once will be sufficient.

Washing.—The papers are placed, with the caoutchouc paper uppermost, for one or two hours, in cold water; this is done in the dark-room. The water should be changed frequently, or continually renewed by letting it run on the paper from a spigot.

Developing.—After the prints have been washed for at least one hour they are placed into the tin developing dishes; the water should be of a temperature of from 90° to 100° Fahr. Sometimes the prints show a tendency to curl up as soon as they touch the water; this does not matter, but the print should be turned from time to time, so as to bring all the parts in equal contact with the water. In from three to five minutes the pigment paper can be separated from the caoutchouc paper; the proper moment is easily ascertained by placing a corner of the print between the thumb and index finger, and rubbing the paper gently in opposite directions; when the papers separate the two corners are seized with the hand and gently pulled apart, however, leaving the paper always immersed in water. As soon as they are separated the paper *upon which the pigment film was at first*, and which very often shows a negative, is thrown out. The other paper is placed into a second dish, containing water of a temperature of about 104° Fahr. The pictures remain in this until all the unchanged gelatine and all the chromates have been

dissolved out, and the print has become plainly visible. If any of the papers should fail to show a picture they must be placed in hotter water.

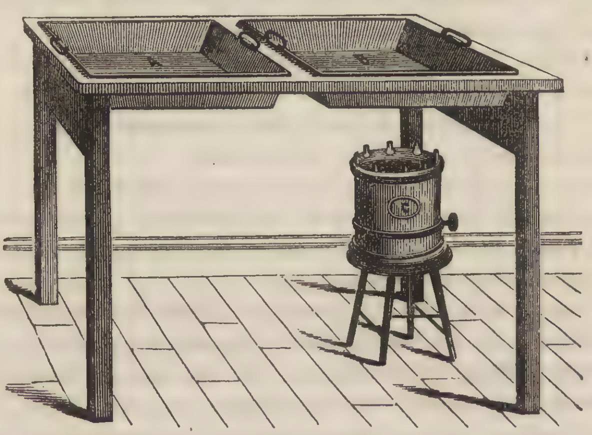
A picture which has been somewhat over-printed, and which appears too dark, may, according to circumstances, be placed in water heated to 110° to 113°, and even 134° Fahr.; by continued washing with increase of temperature we have a means of bleaching. A picture, however, which has been much over-printed, cannot be saved by any washing or increase of temperature.

Under-exposed proofs may be perfectly developed, and slightly washed in water of 100° Fahr. A much under-printed picture cannot be saved by any after-treatment. It is best to commence the washing with the weakest prints.

As soon as the print has been perfectly developed it is placed in clean cold water, which must be frequently renewed; finally, it is syringed with water, and hung up to dry.

Developing-pans of the annexed shape, made of tin, are very well suited for work in small quantities. But the larger the dishes are the better it is. One of the pans is intended for lukewarm, the

FIG. 61.



other for warm water. They are heated either by alcohol or gas. It is convenient to have a thermometer in each pan. It is considered the most convenient to keep the lukewarm water in the right-hand pan, and to transfer those pictures which do not develop perfectly to the left-hand dish, containing water of a higher temperature. Besides the above, two other dishes, containing cold water, are necessary.

The sooner the pigment paper is separated from the caoutchouc paper the better will it be for the picture; it is advisable, therefore, not to place more than from four to six pictures at once into the lukewarm water, that they may not soak too long before being torn asunder. The pictures should not rub against each other.

Transferring.—The picture on the caoutchouc film has the right and left reversed; it is also of an ugly yellow color, which makes a second transfer necessary. Swan performed this operation in a very tedious manner with gelatinized paper. The author demonstrated that this was unnecessary trouble, and introduced the following very simple method. Plain paper, as smooth and white as possible, is dipped for one or two minutes in cold water; it is dried between blotting-paper, in order to remove its gloss; on this the dried and developed picture is laid with the picture side downwards; the hand is gently passed over it to press it to the paper.

It is now placed in the rolling press, exactly in the same manner as described above when treating of caoutchouc and pigment paper. The moist paper faces upwards; on top of this Bristol board is placed; felt is unnecessary.

Passing it once through the press with strong pressure is sufficient; it is next hung up to dry. The pressure of the rollers must be very even, otherwise wrinkles will be the result.

Tanning.—The picture is placed in a solution of chromate of alum after drying it for half an hour—strength 1 : 300; time, 1 minute—and is again left to dry at a temperature of 70° Fahr.; this will require three-quarters of an hour.

Separating.—When the picture is dry, a fine sponge or piece of flannel is taken and moistened with benzine; the print is placed upon a plane surface, and the paper is dexterously rubbed over on both sides with the moist sponge.

The plain paper with the picture attached to it will now easily separate from the caoutchouc paper by detaching one of the corners and gently pulling them asunder. If the paper should stick at some places a little more benzine must be applied; this, however, will not happen when at the beginning the paper has been well moistened with benzine. When, in separating the paper, it is discovered that small particles of caoutchouc remain on the surface, they should be rapidly removed by gently passing the sponge over them; it is always well to rub the moistened benzine sponge over the surface of the picture after the caoutchouc paper has been removed, even if no remnants are noticeable on the print. It is as easy to separate a large picture as a small one.

Frequently the picture will roll off on its own account, owing to the peculiar action of the benzine. If it should happen that parts of the picture stick to the caoutchouc, then it will be necessary to throw the print for ten minutes in a dish of benzine; after that the separation will be easy.

Cutting and *mounting* is done as usual, but very carefully, as the moist prints are very easily injured.

The caoutchouc brush should be kept in a bottle containing benzine, otherwise it will not keep soft and pliant.

Sometimes small blisters will make their appearance during the washing operation; they are caused by small holes in the paper, or by air which has remained between the two varnished surfaces, or also by insufficient pressure in the press. When the first-mentioned circumstance is the cause, then the blisters will disappear on drying, and no injury will result. When they are caused by air-bubbles or insufficient pressure, they can be made harmless by pricking them with the point of a needle from the back of the paper. Sometimes, however, a very annoying bubble will show itself, which will either ruin the print, or which can only be removed after mounting by erasing and retouching. By placing the two gummed surfaces very carefully together before placing them in the press, by *long-continued washing before developing*, and by rolling them with a sure and slow pressure, the bubbles can be avoided almost entirely.

Pictures which are technically called vignettes, are not so easily made on pigment paper as on silvered paper.

The felt which serves for the rolling of the caoutchouc paper must not be used in the transfer process.

The greatest care and attention in not exposing the sensitive pigment paper to light is necessary, both before placing it under the negative and in all the following manipulations which precede the development in hot water.

It should always be remembered that the sensitized pigment paper is much more sensitive to the influence of light than silvered paper. A want of care in this respect is generally punished by a complete failure of the whole operation. I mention this, as I know of numerous instances where persons have lost many pictures because they did not observe the necessary precaution in this respect.

THE USE OF DR. VOGEL'S PHOTOMETER.

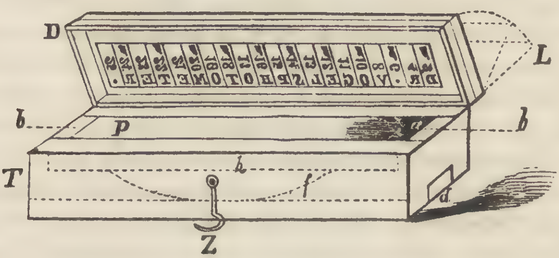
This instrument consists mainly (1) of a *semi-transparent paper scale;* the transparency of this scale decreases gradually from one end to the other; (2) of a sensitive chromate paper, which will retain

its sensitiveness for weeks. The paper is exposed under the scale in a similar manner as a piece of silvered paper is exposed under a negative.

The chromate paper is made by dipping plain photographic paper in a solution of one part of red chromate of potassium to thirty parts of water; the papers are, when dried, ready for use.

The dry paper is cut into strips of suitable size, and the photometer box, *T*, is filled with them. When the lid, *D*, of the box is closed, a spring, *f*, presses the strips against the transparent scale. The scale is fastened to the glass lid, *D*, and can be held in contact with the box, *T*, by the hook, *Z*.

FIG. 62.



When the apparatus is exposed the light will pass through the scale and darken the strip of paper underneath it. This darkening progresses from the most transparent to the least transparent end of the scale, and the progress increases in rapidity with the increase of the intensity of the light.

On the scale black numbers are painted, in order to ascertain how far the action of the light has extended. The opaque numbers do not permit the light to pass through them; the chromate paper, which gets darkened around them, will show a white number on a brown ground.

When the photometer is now examined by lamplight it will be easy to ascertain (by examining the strip of chromate paper) *how far the action of the light has extended, as the last visible number on the chromate paper will indicate it.*

To ascertain the proper printing time of a negative we must proceed in the following manner: A plate containing, for instance, four cartes de visite negatives is exposed to the light simultaneously with the photometer; when the instrument has, for example, reached the number 10, one of the four pictures is covered with a piece of black paper, which is placed between the negative and the pigment paper; the same operation is repeated when the number 12 has

impressed itself on the chromate paper, and so on when it has reached 14 and 16; in this manner the different pictures have been respectively printed to 10, 12, 14, 16.

The picture is developed and examined to see which part shows the proper intensity. The degree of the photometer, for this part of the picture, is the proper degree for the whole negative.

Sometimes the proper printing degree lies between two of the numbers employed, for instance at 13 or 15; when this is the case the picture marked 12 will be a little too light, while 14 is a little too dark; if all the pictures are either over or under printed, the experiment has to be repeated again with respectively higher or lower numbers.

With large pictures, landscapes, &c., a similar experiment as with a carte de visite negative is made by covering successively parts of the landscape, taking care, however, that characteristic parts—bright lights and dark shadows—occur in every part.

A *number* of negatives are arranged according to their density; the practical photographer will easily classify them by looking through them; they are assorted in three classes—weak, medium-dense, and dense; the photometer degree for each class is determined by actual experiment, and all the pictures are printed according to the result.

A new negative is closely examined with the eye, and compared with a negative the printing degree of which is known, and the printing time is regulated accordingly.

When a negative should offer difficulties in determining its density, an experiment is easily made; a characteristic part of the picture, under which a strip of sensitive paper has been placed, is exposed to the light simultaneously with the photometer; the strip is gradually covered, when the photometer has respectively shown the numbers 10, 12, and 14; the strip is then transferred and developed, and examined, in order to see which part has been exposed the proper length of time.

After a few experiments of this kind, and after working for a short time with the photometer and the pigment printing process, the eye becomes so well trained that a glance at the negative is sufficient to indicate the necessary photometer degree.

For the purpose of printing on a larger scale the following method is the most practical: All the printing-frames which one intends to use are filled in the dark-room with paper; they are exposed to the sunlight simultaneously with the photometer; when this instrument indicates the printing degree of the weak negatives, the latter

are taken up and carried into the dark-room, or they are reversed and covered up; and so on with the medium-dense ones and the dense ones. The whole operation will in *fine weather* only take a few minutes. The photometer must be watched very closely, in order to arrest the printing process at the very moment when it has progressed far enough. When all the frames have been taken into the dark-room they are refilled with fresh paper, and the process begins anew. When the saving of time is an object, and where not a minute is to be lost, three photometers, one for each class of negatives, should be employed.

The next thing to be taken into account is the sensitiveness of the pigment paper; American paper, for instance, is twice as sensitive as English paper.

When the photographer receives a paper the sensitiveness of which differs from that with which the photometer degrees have been determined for his negatives, a new experiment becomes necessary, and the result—the difference in sensitiveness expressed in photometer degrees—can easily be added to or deducted from the negatives, as the case may be.

By a single trial (as described above), the degree of a *single negative* is determined for the new paper. When for the old paper the degree of a negative is, for instance, 12, and for the new paper, say 14, it only remains to add simply the difference, 14 — 12 = 2, to all the known degrees of the old negatives, and they will by this simple process be correctly timed for the new paper.

When the new paper has a lower degree, 10 for instance, then the difference, 12 — 10, is deducted from all the known degrees.

The photometer paper is prepared in the following manner:

A sheet of plain Rives or Steinbach paper is cut up into eight equal parts, and immersed by lamplight for three minutes in a solution of

1 part of bichromate of potash,
30 parts of water.

It is the same solution with which the pigment paper is sensitized. The strips are completely immersed, and hung up to dry.

Paper prepared in this manner, kept in dry, clean wooden boxes, from which the light is excluded, will keep for *at least four weeks* without change.

The photometer paper should be made before the pigment paper is sensitized in the liquid; after it has served for the latter purpose, it is no longer fit for the photometer.

The paper is cut into strips of suitable size to fit into the photometer box; the *fingers should be perfectly dry* while handling it. The first and last strips are thrown away. The strips are laid one by one into the open photometer box; the press board is placed in position, and the lid is closed with the spring. The upper glass lid is now opened, by lamplight, in order to ascertain if everything is smooth and even. The papers must be firmly pressed between the strips of tin. When everything is not smooth and even, it is easy to make it so by means of a piece of white paper, which is introduced from the glass lid, and smoothed with the finger. All this must of course be done by lamplight.

When everything is in proper order the box is closed and hooked.

So prepared, the photometer with the lid closed is placed in position *simultaneously with the covered printing-frames;* next the cover is removed from the frames, the lid of the photometer is opened, and the exposure begins. After a short time, say from one to five minutes, according to the weather, the frames are covered again, the lid of the photometer is closed, and the latter is carried into the dark-room, where a lamp is burning.

The instrument is here opened and examined, in order to see which figures have appeared. No. 2 appears first, bright on a brown ground, next 4, then 6, &c.; the higher figures of course much paler. In order to ascertain how far the action of the light has progressed, it is necessary to protect the eyes against bright light.

The open instrument is held below or at the side of a bright flame, at about the distance of eighteen inches, in such a manner that the rays fall vertically upon the yellow paper. With the eye protected against the light, we glance over the paper (in the direction of the figures from 2 to 25). When held in this position it is easy to discern the figures. But not only should the attention be directed to the figures, but also to the index hands and letters, as they materially facilitate the recognition of the slightest light effect on the paper. Turning the instrument gently from side to side will soon enable one to ascertain the most advantageous position.

After a few experiments the necessary expertness is readily acquired.

It must be observed that when one steps from a light room into a dark one, that at first nothing will be noticed, but the eye soon accommodates itself to the dim light, and we are able to recognize all the details.

Similar things occur when we try to read the photometer, and when the eyes are dazzled by bright light.

When the observation is over, the photometer is returned to its place amongst the printing-frames; the lid is opened, the frames are uncovered, and the exposure is continued. After one or more minutes, the photometer is carried back into the dark-room, and re-examined, having previously covered the frames, observing all the precautions enumerated above. When the desired degree has not been reached, the exposure is continued. The time which has so far elapsed, and the figures which have been observed, serve as a guide for calculating how much more time may be necessary to finish the print.

Exceeding the number by a single degree does not amount to much, as the error is easily remedied by longer development. Under-exposure is worse.

When we have negatives of different degrees, we have first to remove those of lower degree, or we may cover them up, and continue the exposure of the balance until their proper degrees have successively been reached.

When all the prints have been made, the frames are carried into the dark-room; the frames are supplied with fresh paper, and the upper yellow colored strip is taken from the photometer *by pressing upon it with the thumb of the left hand;* this lowers the spring lid; both ends of the strip are now pulled from under the tins; the remaining strips are smoothed down, and after closing the instrument, it is ready for another exposure. The upper yellow strip is thrown away.

Photometer observations require the same qualities, which every silver printer should have when he wants to make silver prints:

1. An eye which can discern slight light effects.

2. Care in regard to the photometer paper. The latter is more sensitive than silvered paper, and should be treated with the same cleanliness; it must not be exposed to bright daylight. Particularly in clear weather great care is necessary.

If, through carelessness, the paper becomes affected by daylight, it loses part of its sensitiveness. We must also remark that in the lower degrees the instrument rises very rapidly; in the higher ones much slower.

It is further to be observed that the paper scale must be firmly pressed against the yellow strip, as much so as the silvered paper has to be firmly pressed against the negative.

The paper scale must not be touched with the fingers, and must be kept dry. The glass should always be cleaned previous to using the instrument.

I mention the following degrees, for a negative of medium density, as determined by trial, for different kinds of pigment paper:

Paper by Swan (brown-black),	. .	15 degrees.
" Rowell (gray-black),	. .	11 "
" Beyrich (purple-black),	. .	12 "
" Beyrich (purple-brown),	. .	16 "

JOHNSON'S IMPROVED PIGMENT PRINTING PROCESS.

Until recently the process of Swan was considered the most perfect in use, and justly so when the results which it produced were taken as a criterion. Only one thing remained desirable,—a greater simplicity in the manipulations. This has been accomplished by the very interesting method of J. R. Johnson.

The first advantage which this method offers is the lessening of the number of the necessary pieces of apparatus, and simplifying them. A box 14 inches square and 12 inches deep contains all the apparatus necessary for making pictures 9 × 7 inches. It contains two dishes of japanned tin provided with grooves, two flat dishes of the same material, a stand for plates, several plates of opal glass, some plates of tin or zinc, a bottle with bichromate solution, another with cement (see below), a thermometer, and a japanned box with pigment papers. No strong pressure or rolling press is necessary; neither a large assortment of dishes, &c.

The trough or the plate box is filled with water of a temperature of about 100° Fahr., which temperature can be maintained by placing an alcohol lamp under the dish; a flat dish is next filled with cold water. An exposed sheet is placed for a few seconds in the cold water, with the picture side downward. At first it will curl inwardly, next it will become flat, and would, if left in the water for a longer period, curl outward. *At the moment when it has become perfectly flat, and before it has time to curl outward, it must be removed from the water.*

In the meantime a metal or glass plate (ground-glass is the handiest, as with it it is easier to test the result) is rubbed with a solution of wax, or better, stearine in alcohol; on this plate is laid the sheet with the picture side downward. To avoid air-bubbles, this operation is best performed under water. The paper is next brushed over with a wet, soft camel's hair brush, in order to bring it in perfect contact with the plate. All the plates are prepared in this manner. When we proceed in the above-described manner,

the sheet will remain a little less than one minute in the cold water, which is not sufficient time for the gelatine to become completely soaked with water. After the paper has been placed on the plate, it will absorb all the adhering water, and will adhere firmly to the glass without the aid of a caoutchouc solution.

The wet paper will, however, adhere with the same facility to *any other smooth surface which is impenetrable to water*, as, for instance, canvas prepared for oil paintings, wood, stones, metals, &c. *If the glass has not been coated with wax or stearine*, *the picture will remain attached after development*, *and form a charming transparency or opalotype.* The fatty film prevents, however, a perfect cohesion of both parts, and makes a future separation possible, which takes place at the second transfer.

The reader will already notice several advantages: the expensive caoutchouc solution, which has to be coated on two different surfaces, is omitted; also the unpleasant benzine vapor is avoided. The operations are easier and more rapid, and the press is useless. I must mention another great advantage. As the surface of the paper which is attached to the glass is afterwards the picture surface, it will present either a dull or glossy appearance. The former when ground-glass, the latter when polished glass has been used; and it is, therefore, in any one's power to produce dull or glossy prints at his pleasure.

However, let us return to our subject. The pigment paper, which has been laid on the glass in the above-described manner, will in a few minutes be ready for development. The plates are placed one after the other in the grooves of the trough containing warm water, until the latter is completely filled. In the meantime the paper on the first plate has separated itself from the gelatine film. The paper is lifted off with great care, in order that the gelatine film may remain firmly attached to the glass, and the latter is returned to its groove. When the paper has been removed from all the twelve plates, the development of the first plate will be complete; it is washed in cold water, placed in another box also provided with grooves, and left to dry. When the last plate has so far progressed, the first one will be ready for transfer. For this purpose the plate is dipped in cold water, and under the surface of the plate a piece of gelatine paper is laid, which thus comes in contact with the picture on the glass. Both are now lifted out of the water; the paper is brushed over, as described above, in order to make the contact perfect, and is now left to dry for an hour. Commencing at one

corner, the paper is carefully detached, and as the picture readily separates from the glass, a perfect picture is obtained.

Instead of employing gelatine paper, which in order to make it insoluble has to be treated subsequently with alum, the plate may be dipped at once into a weak solution of gelatine to which has been added a small quantity of chromate of alum. Swan has also recommended this for the last transfer of his prints; or a resinous cement can be substituted for the gelatine, as will be described in the simple transfer process.

Within *one* hour a dozen plates can be got ready for the final transfer, and all the operations may be carried on in an ordinary room, the windows of which have been darkened.

Sufficient has been said now about the simplified process, with double transfer, by which with ordinary negatives a picture is obtained in the proper position. I will now describe a simplified process, with single transfer, by which with correct negatives we obtain pictures in a reversed position. It is evident that for a number of existing negatives this process is inadmissible; but its extraordinary simplicity and effectiveness recommends it when negatives are particularly taken for this purpose, or where the reversion is of no importance.

The pigment sheet is sensitized and exposed, as has been described above. A sheet of fine paper is dipped in a solution of white shellac in liquid ammonia. This is the above-mentioned cement. This paper is next laid on a glass plate, a piece of block tin, or any other similar surface, and pressed to it with a camel's-hair brush. When this is partially dry, the exposed pigment sheet, which has to be a quarter of an inch smaller than the transfer paper, is dipped in water to which a little ammonia has been added, and laid on the transfer paper, which remains on the plate. It is brushed fast, partially dried, and developed as before; next it is washed and dried. The margin is loosened with a pen-knife, and the perfect picture lifted off. Nothing can be more simple and effective than this process.

Simpson, in speaking of it, says: "The method is in fact simpler, easier, and much quicker than the ordinary silver printing process." It is further interesting to know that Johnson employs an ingenious method of sensitizing the paper and quickening its drying by simply floating it for a short time on a five per cent. solution of chromate.

PIGMENT PRINTS ON ALBUMEN PAPER.

Instead of employing shellac, transfers can be made with coagulated albumen paper. Grasshoff and Jean Renaud coagulate it themselves by dipping it for a few minutes in strong alcohol, and drying it. It is self-evident that for this process a very cheap paper may be used. The *moist* coagulated albumen paper is placed on a glass plate, albumen film uppermost. Next the exposed pigment paper, which has been soaked in cold water, is pressed to it in order to expel air-bubbles. The pictures are placed for an hour in a press; finally they are dipped in hot water in order to separate the sheets. The picture adheres to the albumen paper. The picture sheets are placed at once in lukewarm water, and developed in it. The development must be done by lamplight. The dried pictures are tanned, washed, and finished as usual.

Jean Renaud has recently published a communication *on the coagulation of the albumen film with alcohol.* Experience has demonstrated that alcohol dissolves the resinous sizing of the paper. Marbled stains are thus formed on the transfer paper, and when, after the transfer, the operation was carried on in water of too high a temperature, blisters would form on the picture. Jean Renaud has removed this difficulty in a simple manner.

The exposed pigment sheet is placed in a package of slightly moistened blotting-paper. While the sheet becomes pliable, the albumen paper is placed in a large cylindrical glass filled with strong alcohol. It is instantly pulled out again, and placed, dripping wet with alcohol, on a glass plate, the albumen film being uppermost. The pigment sheet, which in the meantime has become pliable, is placed on the albumen paper, gone over with a roller, and is for a few moments pressed well in a press. It is next developed in hot water.

This method has many advantages: a saving of alcohol, which can be used to the last drop; the facility of preparing the albumen paper at the moment when it is needed; the prevention of blisters, even when boiling water is employed; the saving of time, for when the sheets have only been moistened completely with water, we may place them one above the other and press them so as to be able to develop them immediately.

If pigment paper has been over-exposed, or become insoluble by too long-continued drying, the prints may still be saved by placing the pressed papers, previous to the development, for a short time, in a solution of cyanide of potassium (one part cyanide of potassium to one hundred parts of water).

DIFFERENT PHOTOGRAPHIC PROCESSES.

PERMANENT SENSITIVE NEGATIVE PLATES AND POSITIVE PAPERS.

In the previous chapters we have thoroughly discussed the *collodion negative* and the silver and pigment positive printing processes. These methods are sufficient for carrying on the most essential photographic objects. There are, however, circumstances under which the execution of these processes offers difficulties. The negative process requires a *dark-room* for the preparation of the sensitive plates, which the travelling photographer has not always at his disposal. It furnishes wet plates, which dry rapidly, and after a short time become useless. It has been tried to obviate this difficulty by making permanent sensitive dry plates, which can be prepared at home, and carried along on an excursion. Such plates should retain their sensitiveness for a long period, and should not require development until after the return home.

Permanent sensitive positive paper has also been prepared, which, when bought ready made, obviates the unclean work of silvering, and is not liable to the danger of turning yellow in the printing-frame.

Very great efforts have been made to produce permanent dry plates and permanent sensitive papers, which, as regards certainty and beauty of the results, should be equal to the wet process. Every day new dry processes and new sensitive papers make their appearance. It is doubtful which method is the best. So much, however, is certain, that the production of dry plates, as well as sensitive paper, is still very unreliable, and in spite of the greater expenditure of care and time, which the preparation of these bodies makes necessary, success cannot be guaranteed in the same measure as with the wet process.

While in practicing the latter a truly pedantic cleanliness is a *conditio sine qua non*, it is still more so in the dry process.

a. PERMANENT NEGATIVE PLATES (DRY PLATES).

The above-mentioned common fault of negative plates getting spoiled by the drying of the silver solution is obviated by simply washing the plates after silvering. It is best to use distilled water for this purpose, which must be absolutely pure and particularly, free from alkaline reaction. We obtain in this manner, after letting them stand for a short time, plates coated with a dry film of yellow iodide of silver, which, when exposed and developed in the manner described below, will yield a picture. It has been noticed that the degree of sensitiveness of such plates is very small, and an exposure four times as long as in the wet process is necessary. The cause of this is the great transparency of the dry plates. A plate saturated with a solution of nitrate of silver absorbs almost all the actinic light which falls upon it, while a washed plate allows a considerable portion to pass through it, which of course is lost for the formation of the picture. It is, therefore, necessary to prepare the plates with a strongly iodized collodion, which, on account of the large quantity of salt contained in it, will form a denser film of iodo-bromide of silver; this absorbs the light more completely; or else the back of the plates should be covered with an opaque pigment. It should further be observed, that with such washed plates the sensitizer is deficient (*i. e.*, the body which imparts sensitiveness to the slightly sensitive pure iodide of silver), and that from this cause alone the action on iodide of silver is of less intensity. For this purpose it has been tried to replace the wet sensitizer of the silver salts by a dry one. As such, all bodies absorbing iodine can be used. Particularly tannin, gallic acid, and certain resins have been recommended. I distinguish, therefore, amongst dry processes, the tannin, resin, gallic acid, and other processes. With solutions of these sensitizing bodies the washed plates are coated and left to dry. By coating the plates with such a preservative they not only become more sensitive, but also more permanent.

The necessary washing, and coating of dry plates with a preservative make the labor somewhat complicated. The development is still more troublesome; the dry plate must first be prepared for receiving the fluids by soaking in water respectively in a silver solution. The too energetic sulphate of iron developer is apt to give rise to fogs and spots, and the preference is given to the slower acting pyrogallic acid, respectively a solution of sulphate of iron with the addition of organic substances, which have the peculiarity of retarding the chemical reducing process,—for instance, gelatine.

The oldest dry process is that of Taupenot; it consists in the employment of an albumen film, which is silvered afterwards. The albuminate of silver takes here the part of the sensitizer.

It is not my purpose here to give a description of all dry processes which have been practiced. So I shall confine myself to the description of two which I have worked successfully.

1. THE PROCESS WITH GALLIC ACID AND GUM, BY RUSSELL MANNERS GORDON.

Well-cleaned plates should be selected and coated, previous to collodionizing them, with a solution of albumen; 1 part albumen and from 12 to 15 parts of water are well shaken, left to settle, filtered, and sufficient ammonia is added, until it smells slightly of this substance; the plate is placed horizontal, the fluid is poured on it, and the albumen distributed over it with the aid of a piece of card-board, in such a manner that a clear margin of the glass about a sixteenth of an inch wide remains. The excess of fluid is poured off on one corner.

The plates which have been coated in this manner have little tendency to become spotted. Such a coating has also been recommended for the ordinary wet process, particularly when the plates are old, and have been used repeatedly.

The albumenized and dried plates can be kept for a long time in a place *free from dust*. To convert them into dry plates they are coated with a good collodion, such as is used in the wet process (I use my equivalent collodion, see page 96). Gordon recommends the following especially:

Ether,	240 parts.	
Alcohol,	240 "	
Iodide of cadmium,	3 "	
Iodide of ammonium,	1 "	
Bromide of cadmium,	3 "	
Gun-cotton,	6 "	at most.

The silver bath must, under all circumstances, be of a strength of at least one to twelve, and should be as neutral as possible. The time of immersion in this bath is ten minutes, or when the collodion containing the largest percentage of dry salts is employed, the time should be fifteen minutes.

The washing is done in two upright baths filled with distilled water, and placed side by side. Plates that are washed under a running stream are apt to become streaky. When the plates are

taken out of the second bath they should be placed for two hours in a comparatively large quantity of distilled water, or they may be dipped successively in four baths filled with distilled water. Afterwards they are washed again with ordinary hydrant water under the spigot. They are then rinsed with distilled water from a wash-bottle, and coated with the following solution:

I.	Gum arabic,	20 parts.
	Rock candy,	5 "
	Water,	120 "
II.	Gallic acid,	3 "
	Water,	360 "

No. II should be prepared in a warm place; it is mixed with No. I in the given proportions, and filtered before use. Air-bubbles must be avoided.

Every plate requires 15 grammes (231½ grains) of the gum preservative. 4 grammes (62 grains) of it are taken to remove the water, the remaining 11 grammes (170 grains) are left on the plate for about a minute; the liquid is then poured off, and the plate is drained. The latter operation is much more easily performed by placing the corners in small glass tubes which are fastened to boards. The tubes are filled with blotting-paper, which can easily be renewed without injury to the plates, as they rest only with one corner on the tubes. The latter should have a diameter of about a quarter of an inch. When these glass stands are not at hand small tumblers may be employed, which, in order to give them more firmness, are fastened to the table of the drying-room; the upper corners of the plate rest against glass surfaces; it is well to number the plates after they have been placed in position.

The drying-room is a large wooden box or a kitchen closet, which can be closed against the light, provided with shelves so as to permit the placing of several rows at the same time. On the top is a chimney, bent twice at right angles, similar to the chimney of a magic lantern. In damp weather a tin vessel containing hot water is placed in the centre of the drying-room; in summer-time this is generally unnecessary. The usual time for drying the plates is from ten to twelve hours; the film will then appear transparent, and the backs of the plates must be coated with a film of pigment.

To prepare eight stereoscopic plates it is necessary to take:

Burnt terra sienna, divided in water,	100 grammes (3 oz., 231 gr. avoirdupois.)
Dextrine,	30 grammes (1 oz., 25 grains).
Glycerine,	2 grammes (31 grains).

A trace of carbolic acid or creosote will prevent the mixture from spoiling. It is filled in tin tubes, such as are used for artists' colors, so as to be always ready for use. The backs of the dry plates are brushed over with this color. It is always well to leave a narrow margin around the plate, in order to prevent the pigment from touching the picture side. After drying, the plates can be packed away.

Exposure in the Camera.—The dry plates are exposed two or three times as long as the wet plates. Dry plates can stand long exposure without detriment. Generally, want of success is caused by too short an exposure. Too long an exposure can be remedied by a suitable development.

Development.—The pigment is removed from the back of the plate with a wet sponge; the margin of the negative is coated for about one-eighth of an inch with a thick solution of caoutchouc in benzole or chloroform; it is then immersed in a bath of ordinary water, and rinsed twice with distilled water in order to remove the preservative. It is now developed with the following developer:

I.	Gelatine, ...	10 parts.
	Glacial acetic acid, ...	160 "
	Water, ...	1120 "
II.	Sulphate of iron, ...	25 "
	Water, ...	500 "

For use, one part of the gelatine solution is mixed with three parts of the iron solution. For every plate take about 30 grammes (1 oz., 25 gr.), and add two drops of a solution of nitrate of silver (1 : 16). The percentage of silver is increased by always adding two drops more until all the details make their appearance.

Intensify with an ordinary citric and pyrogallic acid solution. For instance:

Pyrogallic acid, ...	2 parts.
Citric acid, ...	2 "
Water, ...	480 "

The *fixing* is done with hypo. The negative is subsequently subjected to a supplementary treatment with pyrogallic and acetic acids (and silver); the object of this is rather to change the color of the precipitate than to increase its thickness.

Fog can be reduced to a minimum when to every ounce of solution of gum ten drops of glycerine are added. By this modification the film does not become transparent after drying, and

works almost like a wet plate. It has, however, the drawback that it will only keep for two weeks.

The reader will notice that this is rather a tedious and laborious process.

The resin dry process is simpler. The preservative (any resin, for instance colophonium) is added directly to the collodion, and the plate is silvered and washed.

Abbé des Pratz was the first who introduced this process. Mr. England practiced it afterwards, and lately Mr. Harnecker, in Briezen, has made it a specialty.

2. THE RESIN DRY PLATE PROCESS OF HARNECKER.

A well-cleaned glass plate is coated with common collodion, to which for every 100 grammes (3 oz., 231 gr.) one-half a gramme of resin ($7\frac{7}{10}$ gr.) is added. When the last drop, after pouring off the excess, has become dry, the plate is dipped in a good working silver bath:

Silver, ...	15 parts.
Water, ...	130 "
Nitric acid, ...	2 drops for every 4 oz. of solution.*

The most suitable temperature is 65° Fahrenheit; the time of sensitizing 5, 8, and 10 minutes. The medium time is generally the best. The silver plate is first well washed with filtered distilled water, and next thoroughly washed with ordinary water. Finally it is rinsed with distilled water, and placed on one corner to dry, at a temperature of not less than 70° Fahrenheit nor more than 100°. When dry the plates are ready for use.

The *exposure* is, according to the intensity of the light or the age of the plate, twice or three times that of a wet plate. Fresh plates are much more sensitive than old ones.

The plate is, previous to the development, placed into a dish containing filtered distilled water (it is best to make the water slightly acid). The dish should be moved to and fro, and the plate soaked in it for from five to ten minutes. It is then taken out and placed in the same silver bath in which the plate has been originally sensitized. It is raised and lowered from eight to nine times, and developed like any other wet plate.

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* I give above the original receipt, but believe it would be well to add to the silver bath one-quarter per cent. of the dry salt of iodide of potassium.

The developer consists of:

Sulphate of iron,	1 part.
Water,	220 parts.
Glacial acetic acid,	3 "
Alcohol,	4 to 5 parts.

Intensified with the following solutions:

a.	Pyrogallic acid,	5 parts.
	Water,	2560 "
b.	Nitrate of silver,	15 "
	Water,	720 "
	Glacial acetic acid,	32 "

Fixed with a solution of hyposulphite of soda. The development can also be made by pouring the above iron solution over the soaked plate. It is moved for a few seconds over the plate, poured back into a glass, and then are added two, or at most three, drops of a silver solution, consisting of:

30 parts of silver dissolved in 720 parts of water, and mixed with the following fluid:

30 parts of citric acid dissolved in 720 parts of water.
60 " alcohol.

The picture becomes visible at once, and the plate can be washed after the fluid has been poured over it several times, and the image appears clear and perfect. After washing with ordinary water, the picture is reintensified with pyrogallic acid; but the acid must be used without the addition of silver in order to avoid fogging. After the pyrogallic acid has been poured off and on several times, citrate of silver is added for intensifying. If care has been taken in the preparation of the plate, not to have the collodion too dry before the plate is dipped in the bath, and it is left immersed sufficiently long, and afterwards well washed, a satisfactory result is certain, particularly when pictures in the *open air* and *landscapes* are taken.

The development can be made at any time after the exposure.

As regards the numerous other dry processes, such as the tannin, gelatine, coffee, tea, which are always tried over and over again, and always recommended, I must refer the reader to the photographic periodicals whose province it is to report the progress made in this direction.

To any one who desires to work any of these processes, I must recommend once more the greatest care and cleanliness in the

treatment of the preparations. A slight impurity, which in the wet process would perhaps be passed by unnoticed, may cause a perfect failure in the dry process. Many dry plate pictures owe their ill success solely to the employment of distilled water which was not perfectly pure. But apart from this, the tedious mode of preparing dry plates will frighten a great many. Time is money; and very often the packing and unpacking for an excursion of the necessary apparatus and chemicals of the wet process offers much less difficulty and loss of time than the preparation of a number of dry plates. The dry plate process will only then become practically useful, when such plates can be prepared at not too high a price for the trade, so as to save the photographer the trouble of making them himself.

b. PERMANENT POSITIVE PAPERS.

Mr. G. Wharton Simpson, of London, the well-known editor of the "Photographic News," recommended a paper four years ago, which had been coated with a collodion containing chloride of silver, in place of the albumen paper.

Such paper yields prints as beautiful as those on silvered albumen paper, and has besides a peculiarity which escaped the notice of the inventor—*i. e.*, that it keeps for an unusual long time. Papers which are made in this manner, provided they have been properly prepared, have been kept for weeks without change, while silvered albumen paper turns yellow in from one to three days.

Obernetter, in Munich, was the first to make such a chloride of silver collodion paper for the trade. It yielded excellent results, but unfortunately the surface proved very delicate, and the paper had a tendency to curl in the wash water. Later, Carrier, in Paris, and Ost, in Vienna, have furnished similar preparations; the latter has published his process in a pamphlet, an extract of which I will give below. Quite recently a permanent albumen paper of different composition has been brought out by Schaeffner & Mohr, in Paris. It is called carbonate of silver paper, and is made sensitive by fuming with ammonia.* The treatment it requires is the same as ordinary silvered albumen paper, while the collodion papers require a somewhat different management. The carbonate of silver paper has the advantage over collodion paper on account of its being cheaper, more durable, and offering greater resistance to mechanical injuries.

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* Probably this paper of Schaeffner & Mohr is nothing but silvered and washed albumen paper.

It is evident that a chloride of silver collodion film can be used not only on paper, but also on glass, wood, enamel, &c., and this circumstance enables us to produce the pictures on almost any given materials, either by preparing their surfaces directly with collodio-chloride of silver, and then passing them through the copying process, or by finishing the picture on the collodion paper, detaching the film, and transferring it to the desired object.

COLLODIO-CHLORIDE OF SILVER.

Ost uses two kinds of collodio-chloride of silver in the preparation of his papers:

Collodion No. 1.

Plain collodion (containing $1\frac{1}{2}$ to $2\frac{3}{8}$ per cent. of gun-cotton),	500 parts.
Chloride of magnesium, ...	4.5 "

To this collodio-chloride of magnesium the following solution is added:

Nitrate of silver, ...	11 parts.
Water, ...	16 "
Alcohol, 40°, ...	16 "

The nitrate of silver is first dissolved in the given quantity of water, the alcohol added, and the solution thus formed is poured into the bottle containing the collodio-chloride of magnesium. This must be done in a dark-room, and the solution well shaken. To the milky collodio-chloride of silver thus obtained, the following substances are added while it is being constantly shaken:

Citric acid, ...	4 parts.
Dissolved in water, ...	8 "
Alcohol, 40°, ...	8 "

Collodion thus prepared will keep for weeks.

Collodion No. 2.

Plain collodion (as above), ...	625 parts.
Chloride of magnesium, ...	3.75 "

To which is added the following solution of silver:

Nitrate of silver, ...	16 parts.
Water, ...	16 "
Alcohol, 40°, ...	16 "

To this is added the same solution of citric acid as above.

Both collodions are left to stand quietly for a few days; they are then decanted from the sediment and ready for use.

COLLODION PAPER.

As a foundation for this collodio-chloride of silver, a kind of glazed paper had better be used, which Ost prepares as follows: A gelatine albumen solution is spread with a broad brush as evenly as possible on plain photographic paper. This is brushed away with a badger's-hair pencil, and left to dry. The dried sheet is coated a second time, dried, pressed, and finally brushed, after which it shows a fine and glossy surface.

The gelatine albumen solution is prepared as follows: The white of twenty eggs is beaten to a froth and cleared by settlement. The clear solution is mixed with an equal volume of a lukewarm gelatine solution, which has been cleared by settlement (1 part gelatine, $4\frac{1}{2}$ parts of water), and in this mixture 3 to 4 pounds of white of baryta and one-half a pound of (feather white?) must be stirred. The solution must be poured on while it is warm.

The coating of the paper with collodion is very easily done by fastening the paper with two drawing pins to a smooth wooden foundation, and pouring the collodio-chloride of silver on it in the same manner as on a glass plate. The paper is first coated with collodion No. 1, and left to dry by suspending it with slips; it is next coated with collodion No. 2, the excess of which is poured off on the corner opposite to the one from which the first solution has been poured off; after it has been dried again the paper is ready for use.

Obernetter's prepared paper is an article of trade. The time of printing with this paper is but half as long as for albumen paper, and is therefore particularly recommended for winter use, and also for *enlargements*.

Before toning, the prints are washed with ordinary water (5 to 10 minutes) in order to remove the greater part of the free oxide of nitrate of silver.

I. Dissolve in $1\frac{1}{2}$ litre ($3\frac{1}{10}$ pints) of distilled water,
Sulpho-cyanide of ammonium, 40 grammes (1 oz., 180 gr.),
Hyposulphite of soda, 4 grammes (62 gr.).

II. Dissolve in $1\frac{1}{2}$ litre ($3\frac{1}{10}$ pints) of distilled water,
Chloride of gold, 2 grammes (31 gr.),
or in place of it 3 grammes (46 gr.) of gold salt.

These two solutions will keep for any length of time. For use,

equal portions by volume of the two solutions are mixed and may be used at once for toning. In this way one is enabled to make without scales, quickly, a small quantity of gold toning bath, sufficient for a few pictures. An exhausted bath is strengthened by adding a few drops of chloride of gold solution. When the copies have reached the desired tone (2 to 10 minutes), they are washed and fixed in the following carefully compounded solution:

Hyposulphite of soda,	40 parts.
Common water,	1000 "

From 5 to 10 minutes are sufficient for fixing it. The washing is done as described above.

It is advisable to moisten the prints previous to mounting, as this will prevent curling; or it is still better to mount them while moist. By passing them through the rolling press, with strong pressure, they obtain their full beauty.

To make these pictures less liable to mechanical injury, Ost recommends the following varnish as a covering for the finished pictures:

Benzine,	2 pounds.
India-rubber,	½ ounce.
Mastic,	1 "
Canada balsam,	¼ "

TRANSFER PAPER AND TRANSFER PICTURES.

As foundation for the transfer a photographic paper which has been coated with a gelatine solution of 1 : 13 serves well. The paper is coated with collodio-chloride of silver in the same manner as a negative plate is coated with negative collodion, with this difference, however, that the coating is repeated when the first film has become dry; the excess is allowed to run off from the corner which in the first draining was uppermost. In this way greater evenness is obtained. The paper will keep for months.

To produce a picture, the paper is exposed under a negative, washed, toned in a bath of Rhodan gold, after Obernetter's process, and fixed. These operations are no doubt well known and handy to most photographers. It is different with the transferring operations, which Mr. Ost describes as follows:

The Transferring.—After the last washing, the pictures, owing to the contraction of the rather strong collodion film, show a tendency to curl, which would be rather inconvenient for the transfer.

This inconvenience is easily obviated by drawing the pictures singly and rapidly through warm water; they become flat at once, and will remain in this condition if they are placed in a second dish filled with cold water. Such an operation will require, for several hundred pictures, but a few minutes.

When we wish to transfer to glass or paper, the photograph is laid with the picture side on glass-paper,* and immersed for half a minute in tolerably warm water; the paper can then with the greatest ease be drawn off the collodion film (which contains the picture). The glass-paper with the collodion film is placed on a plate of glass, which should be a little larger than the paper, and with a broad varnish-brush the gelatine which still adheres to the collodion is removed, by the aid of warm water. The operation occupies but a few seconds. A Bristol board† is laid on a piece of clean blotting-paper, and about a teaspoonful of thin boiled gelatine of the following proportions is poured upon it:

Fine gelatine, ...	1 ounce.
Water, ...	25 "

The glass-paper with the collodion picture is lifted from the glass and pressed, with the picture side towards the Bristol board, on the surface of the gelatine; the varnish-brush is passed several times over the glass-paper, by which operation the excess of gelatine will be squeezed out, and by seizing carefully the glass-paper at one corner, it is gently lifted from the Bristol board. The collodion picture has now been transferred to the board. Slight wrinkles which the film may still show will disappear after drying.

For this purpose the finished pictures are laid on large sheets of paper, which have previously been saturated with a hot solution of one part of lard and one part of wax; the sticking of the glazed Bristol board, to the corners of which the gelatine solution adheres will thus be prevented.

Such sheets prepared with fat can be used for years.

The transferring to glass is done in the same manner, only substituting glass for Bristol board, and selecting strongly exposed pictures.

In the transfer great care is necessary in order to avoid air-bubbles between the collodion film and its foundation (Bristol

* Glass-paper is a paper which has been brushed with a good copal varnish, which imparts to it a glass-like transparency.

† If glazed Bristol board is used, the picture will show after drying a glass-like lustre. Ordinary board interferes with the beauty of these prints.

board, glass, porcelain plates, &c.). After a short practice the necessary skill is acquired.

It must further be remarked, that, in order to have warm water constantly at hand during transferring, the following arrangements must be made: An iron tripod of about three inches in height is placed on the work-table, and on the former is put a glazed kettle (such vessels can be obtained at any house-furnishing establishment); the kettle should have a diameter of from nine to ten inches, and a depth of about three inches; it is half filled with water, and is heated by an alcohol lamp. The water is used for the drawing off, for the cleaning of the pictures from gelatine, for keeping the broad brush warm and wet, and also for heating the gelatine.

Transferring to oval or round Porcelain Plates.—Transferring to oval or round porcelain plates differs in so far as the binding medium is not gelatine, but copal varnish.

When we wish to make a brooch on porcelain or an enamelled plate, the picture intended to be transferred is cut in such a manner that on every side it will be a quarter of an inch larger than the plate. It is placed with the picture side on the glass-paper, and is now freed from paper and gelatine by means of warm water, in exactly the same manner as in the previous process; the margins and surface of the porcelain plate are now brushed with light copal varnish, which has been considerably diluted with chloroform; about one part of varnish to five or six parts of chloroform. This solution is kept in a well-corked bottle. Only small quantities should be taken out for use, as the chloroform evaporates very rapidly.

The varnish is laid on with a medium sized fish-brush;* it should be done in quick and even strokes; the brush must contain only very little varnish, and not be more than half wet. The varnished plate is placed on the corner of the table; the collodion film is pressed on and freed from the glass-paper; the protruding end of the film is laid around the edge of the plate, and by drawing it tight the wrinkles are removed as much as possible. A further smoothing is produced by rubbing first gently, and afterwards firmer, with fine cotton, such as is used for filtering collodion.

It cannot be denied that a certain amount of practice is requisite in order to be able to transfer with varnish on medallions, and in the beginning the attempts will frequently result in failure; if, however, the operator has overcome the first difficulty and gained some

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* The above expression refers probably to the shape of the brush, being similar to that of a fish tail.—TRANSLATOR.

experience, it will be found that the process works rapidly and without trouble. Ost says: "I transfer about forty medallions in an hour without spoiling a single one."

On the unsuccessful plates the collodion film adheres firmly to the porcelain, and can only be removed perfectly with great difficulty. The best way of cleaning these is to let them lay over night in caustic soda.

Objects whose form prevents stretching cannot be transferred with copal varnish, as the collodion film is contracted by the varnish, and gets full of wrinkles.

The transferring on vases, dishes, goblets, glasses, cups, bottles, &c., which have to be frequently washed while in use, cannot be done with gelatine, as this dissolves readily in water. An insoluble transfer photograph can be obtained on them if albumen is employed in the place of gelatine. For this purpose the white of several eggs is beaten to a froth and cleared by settlement; the decanted and limpid albumen is used instead of the gelatine solution. The collodion film adheres very well to this substance.

Objects ornamented in this manner with photographs are finished by gradually heating them to about 190° Fahrenheit, at which temperature the albumen coagulates and becomes insoluble in water.

POSITIVE PICTURES PRINTED DIRECTLY ON GLASS, PORCELAIN PICTURES, AND THE REPRODUCTION OF NEGATIVES.

The white of four eggs is beaten to a froth with four ounces of water, left to clear, filtered through a cloth, and spread on well-washed glass plates. The coating is made more even by the aid of a glass rod, and the plates are left to dry in a place free from dust. They will keep for months. In order to prepare them, they are first coated with Collodion No. 1, and after they are dry, with Collodion No. 2 (see page 187); they are dried again and printed in a printing-frame under a negative, which is backed by black cloth. It is easy to control the printing, as the picture becomes visible through the glass. The prints must be vigorous. The plates are washed, toned, and fixed in the same manner as collodion paper (see above), and thus a fine transparency will be obtained which resists mechanical injury without varnish.*

If this operation is repeated, a new negative can easily be made from the positive. For this purpose, however, a very intense print

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* This process can of course only be used with flat negatives.

is required, and the best way will be *not to tone at all* a positive prepared with this intention, but to fix it at once, by which it obtains a brown and non-actinic color.

If an enlarged print is desired, the positive is to be treated as stated below.

Monckhoven published a short time ago some extremely important remarks about the reproduction of negatives by means of collodio-chloride of silver. He says:

"I have latterly paid a great deal of attention to the chloride of silver process, and will now give some of my discoveries, which will enable the photographer to successfully produce new negatives.

"I formerly believed that plates prepared with collodio-chloride of silver ought to be over-exposed in order to obtain vigorous results. But I soon found out my error, and at the same time I made a discovery the practical importance of which will be evident to every one.

"The same unforeseen phenomenon of solarization appears with the chloride of silver plates as with the iodide of silver plates, and in such a manner that if a plate of this kind has been exposed too long to the action of light, all the shady parts acquire by reflection the well-known metallic lustre, while by looking through them the red tint will be noticed, in which all the details will gradually disappear. This is the beginning of solarization or over-exposure.

"The light acts on chloride of silver (with excess of nitrate of silver) in exactly the same manner as it does under the same conditions on iodide of silver, *i. e.*, *up to a certain point.* When that point has been reached a *retrograde* action sets in.

"I have now tried to avoid the solarization of the chloride of silver plates, or at least to defer it, and I succeeded in this by exposing them to the vapors of ammonia.

"If a chloride of silver plate is cut in halves, *the one exposed to the vapors of ammonia*, and both printed under a negative, the difference is very perceptible; the one will be solarized very soon, while the other will give a vigorous picture without the appearance of solarization.

"After these theoretical explanations, I will now state my mode of working.

"I prepare separately the following solutions:

a. Normal collodion—

Gun-cotton,	1 part.
Ether,	32 "
Alcohol,	32 "

I let it settle thoroughly, and only use the portion that is entirely clear.

b.	Chloride of magnesium,	1 part.
	Alcohol, 38°,	8 parts.

After the chloride has dissolved, the solution must be filtered.

c.	Nitrate of silver in powder,	20 parts.
	Distilled water,	30 "
	Alcohol,	56 "

The silver is first dissolved in water, the alcohol then added, and finally filtered.

d.	Citric acid in powder,	18 parts.
	Boiling water,	18 "
	Alcohol,	128.6 "

The citric acid is first dissolved in boiling water and the solution filtered after the alcohol has been added.

"For compounding the collodion a brown Rhine wine bottle is taken, for in such it will keep white in open light. It is filled with 600 parts by measure of normal collodion (*a*), and 50 parts by measure of chloride of magnesium solution (*b*). This is well shaken, and 60 parts by measure of silver solution (*c*) added; the bottle is closed and shaken for a few minutes. 40 parts by measure of the citric acid solution (*d*) is now poured in; it is shaken again, and the collodion put away for eight or ten days, for it improves with age.

"I must call the attention of the reader to the fact that he must strictly observe the above-mentioned formulæ, for the preparation of collodio-chloride of silver must be carried on with exactness. If too little silver is present, the collodion is insensitive to light; too much silver produces crystals on the surface of the plate. In the former case silver salt is added; in the latter chloride of magnesium.

"This collodion has an opalescent color. It will not form a precipitate if it has been correctly prepared.

"The plates, after being carefully cleaned, are coated with albumen which has been diluted with its own volume of water; they are then well dried and collodionized. The collodion must be poured on very slowly in order to obtain a thick film. This is much better than to provide the plates with a double film of collodion, as, unless this is done with extraordinary skill, the second application of col-

lodion will partially dissolve the first. Before exposing the chloride of silver plates, they are subjected to the vapors of ammonia.

"The ammonia is placed in a watch-crystal, which is placed at the bottom of a box provided with horizontal grooves. The plates are laid three or four inches above the glass containing the ammonia; they are exposed for three minutes to the vapors, left for half an hour in the air, and placed in a printing-frame with the negative.

"Toning and fixing is done according to the directions given above."

About the reproductions of negatives by means of the camera, see the chapter on Enlargements.

PRINTING BY DEVELOPMENT.

As we have before observed, the direct printing process has, by the excellence of its results, maintained its precedence over the printing with development, in spite of its slowness. There are however, cases where, under certain circumstances, a preference is given to a sensitive process. For instance, in making enlarged pictures with feeble light, also for the production of prints in great quantity, where cheapness is of more importance than beauty. For such purposes several methods have been tried, and specially prepared papers have been employed. Very beautiful results are obtained on collodion paper. It is, however, only suitable when freshly prepared. Such a preparation does not offer any difficulty now, as the ready made collodio-chloride of silver, as well as gelatine paper, are easily obtained through the trade.

For the production of developed pictures on *collodion paper*, Obernetter recommends: Printing until the outlines of the picture become visible; next immersion in the following solution:

Water, ...	1000 parts.
Pyrogallic acid, ...	½ "
Citric acid, ...	¼ to ½ "

When the picture has developed with sufficient vigor, it is washed, toned, and fixed, the same as ordinary collodion paper pictures. (Monckhoven's printing process and printing by development follows below, under the chapter "Enlargement with Development.")

ENLARGEMENTS.

THE photographer is often called upon to furnish an enlarged positive from a small negative. This can be accomplished by different methods.

Every lens forms a *reduced image* of an object when it is removed further from it than twice the focal length. When an object is nearer to the lens than twice its focal length, the image formed by the lens will be enlarged.

A person five feet high, placed at the distance of twenty feet from a carte de visite lens, will have an image of three inches in height projected on the ground-glass, and *vice versa*, this same lens can produce a *life-size* picture from the small negative at a distance of twenty feet. The brightness of such an enlarged image decreases with the increase of surface, and it is evident that the negative which is placed at the focal distance from the lens must be brilliantly illuminated if we wish to obtain a bright optical image, and this illumination should be the more intense the larger the desired picture is to be.

For a moderate enlargement, six to eight times.

1. THE INDIRECT COPYING PROCESS

Will be sufficient. With the ordinary chemicals a transparent positive is made of the size of the original; this can either be done with the camera or with collodio-chloride of silver.* From the positive an enlarged negative is taken.

Two cameras are used for this purpose; the fronts are placed to face each other, and from one of the cameras the lens is removed. The objective of the second camera will project into the first camera; the latter serves merely as a proper receptacle for placing the negative and to exclude side-light. The negative, which has already received the necessary retouch, is placed in the plate-holder of the first camera, and kept in position by small pieces of wax,

* Monckhoven gives the preference to collodio-chloride of silver.

and the plate-holder is placed in the camera. The whole system is best placed on a long and very solid stand, opposite to a window, with an unobstructed view of the sky.

I generally make such work in the glass-house. The base of the stand is placed in an inclined position, and the light, with the exception of a space ten feet square, is excluded. I place the stand with the cameras opposite this opening.

It is advisable to exclude all superfluous light. When the back of the negative receives light, it will look partially positive, owing to reflection. This of course may give rise to a false effect, and it is better to cover a black cloth over the space where the two cameras are joined together. And the light which passes through the transparent margins of the negative also exercises an injurious influence. The negative acts like a kind of window admitting DIFFUSED light into the camera, and disturbs the clearness of those parts which should remain transparent in the picture which we desire to produce.

To obviate this, an opaque mask is placed in front of the negative, in which an opening has been made sufficiently large to illuminate the picture. Window bars and other dark objects in the visual line of the apparatus are disturbing elements; to make them harmless, a piece of fine ground-glass is placed in front of the negative in order that the light must first pass through the former before reaching the negative. The back shutter of the plate-holder, in which the negative rests, is prevented from shutting by some simple contrivance.

A correct drawing lens of short focus is selected as an objective. Carte de visite lenses of four inches focus, triplets, or aplanatic lenses, answer for this purpose. The bellows of the back camera must of course admit of sufficient extension when a large picture is desired.

Card and triplet objectives should be fastened in a reversed position to the camera (the back lens being front). If we desire, for instance, a picture nine times magnified, we place the apparatus in such a manner that we receive a positive which has been magnified three times; by repeating the operation without changing the position of the apparatus, and substituting the magnified positive in place of the original negative, we will get a picture which is 3×3, or nine times as large as the original negative. It is only necessary to focus once, after which the proper stops can be inserted. The exposure *should not be too short.* The developed positive *should show by transmitted light the same delicate details*

in light and half tone as a fine paper print taken from the same negative would represent. A fully exposed positive, soft and very sharp, is absolutely necessary for enlargements.

The beginner must not think that he has succeeded when a clean positive plate has been produced. Before proceeding further, he should examine it very carefully in order to ascertain if it is rich in detail. Sir H. Davy says, expose the positive until it shows a slight precipitate in the bright parts. Intensifying is unnecessary. When a good positive has been obtained, the enlarged negative is made from it in the same apparatus. Another way is to make a positive on collodio-chloride of silver by the direct process, which has been described above. But aside from *focussing*, which with enlargements requires some patience, the work with the camera is the most convenient.

It is of much advantage to know the equivalent focus of the objective for the purpose of focussing (see directions). If this is known the negative and ground-glass can be placed at about the distance of the equivalent focus, which will save a tedious adjustment. For pictures of original size the distance of the original (negative) as well as the collodion plate, for instance, is about equal to twice the length of the focus. For enlargements the distance of the original is less than twice the focus. Meagher, in London, has constructed a camera with long bellows, which, in the centre of the bellows, has an arrangement for placing the objective, and in the front part of which the negative is easily inserted. All the parts are easily brought nearer or further removed by endless screws, and sharp focussing causes no trouble. Any one who has to work much in this branch will do well to make marks on his camera, which indicate how far the same has to be drawn out for different enlargements.

The avoidance of any shaking of the apparatus during exposure is absolutely necessary. Any, even the slightest motion shows in the enlargement in a heightened measure, and produces a want of sharpness. Care should be taken to have a solid basis, and running about, and opening and shutting doors, &c., must be avoided. Sometimes a vibration is caused by the opening of the objective. I am in the habit of altogether dispensing with a cap, and admit or exclude the light with a small piece of blackened pasteboard, which is placed in front of the negative, and can easily be taken away for the purpose of exposure. *I have still to remark that it is advisable to subject the transparent positive, which has been obtained in the first operation, to careful retouching before we take a new negative from it.* In this manner negatives can be made,

which, even in an artistic view, surpass the original. From an enlarged negative the positive is made in the usual manner.

2. THE DIRECT COPYING PROCESS.

The enlarged image is projected at once upon *sensitive paper*, and either printed completely or brought out by development. In the latter case a feeble light will suffice; in the former a very intense illumination of the negative is necessary, and this is accomplished by the *rays of the sun*, which either directly, or with the aid of a reflector, fall vertically upon the negative. In both cases the rays are concentrated with the aid of a large condensing lens. *Enlarging apparatus* has been constructed for this purpose.

Dependence upon solar light is generally a great drawback to this kind of work, particularly in northern latitudes, where the rays of the sun possess but feeble power. For such regions the employment of a printing process with development will recommend itself.

In selecting the negatives for enlargement it must be observed that every, even the smallest, fault is magnified, and hence such negatives must be real *ne plus ultras* as regards sharpness, clearness, softness, and purity of the glass. It is customary to employ negatives for the direct copying process, which have not been varnished, as the delicate impurities which are suspended in the varnish exercise an injurious influence, besides the great heat of the concentrated solar rays is apt to soften the varnish.

For moderate enlargements a long camera of large dimensions is sufficient; for larger sizes it is better to use a dark-room which has especially been constructed for this purpose, but unless there is a great demand for these pictures its construction will not pay.

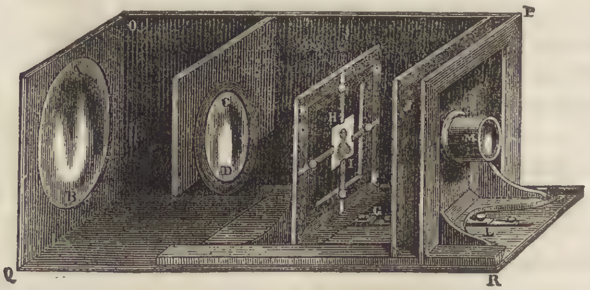
In order to give the reader an idea of an enlarging establishment I will publish below the description of Monckhoven's apparatus.

The same is placed in a dark-room of from 13 to 16 feet in length; the window faces almost south; in front of it is a mirror constructed entirely of iron. By a rack and crank movement such a position can be given to the latter that the reflected rays will fall almost horizontally on the condensing lens of the solar camera. The movement of the mirror is very convenient. It is only necessary to move it about every 20 seconds, in order to keep the rays constantly in the same direction.

Fig. 63 represents the solar camera with the sideboards removed so as to show the interior arrangement.

The lens A B is the condenser, the diameter of which varies according to the power of the apparatus. Its curve is so calculated that its spherical aberration is reduced to a minimum.

FIG. 63.



At the distance of its diameter a second lens is placed, very thin and of the form of a watch crystal, which compensates perfectly the spherical aberration of the first lens. It follows that the field of illumination is not, as in the old apparatus, stronger on the margins of the negative than in its centre, but perfectly even over the whole surface of the original; for every separate point of the margin is penetrated only by a single bunch of rays, and thus, in the dialytical apparatus, the margins of the enlarged pictures are rendered as sharp as the central parts, which is not the case in the old apparatus.

The original picture, H I, is so cut down that only the part which is to be enlarged remains, and is placed into the conus of rays. Formerly the great heat which was concentrated on the negatives was apt to break them. By introducing the arrangement illustrated in the figure this is obviated.

The negative may be of any size, and its enlargement on a sheet of *given dimensions*, sensitized with chloride of silver, always requires the same space of time. Hence, when we have a negative of one-fourth, one-third, or card size, and wish to enlarge it to a bust picture of life size, on a double sheet of one metre, the time required will be the same as if the whole figure were enlarged on a sheet double the size.

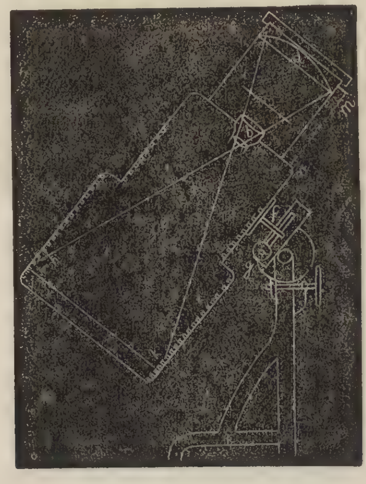
The objectives are of peculiar construction, and are provided with central or back stops, which intercept the diffused light without detriment to the light of the condenser.

The objectives are movable, and admit of the enlargement of any negative between one-fourth and one-half size, on albumenized,

or salted paper, &c., as well as on collodion. Other objectives can be combined with the apparatus, which admit of the enlargement of negatives of $\frac{1}{2}$, $\frac{1}{1}$, &c., sizes, with the same rapidity and completeness.

The American enlarging apparatus is much simpler than Monckhoven's. It consists of a large box, which, by a rack and pinion

FIG. 64.



movement, is directed towards the sun. The condensing lens is placed at *d*; the rays of the sun fall vertically upon the latter. The mirror (which always absorbs light) is, therefore, omitted as useless. The objective is placed in the box at *b* in such a manner that a cone of light is concentrated upon it. The negative *c* is placed in a frame in front of the objective (between *d* and *b*). This frame can be moved with a rack movement for the purpose of focussing. The picture is projected on a movable drawing-board at the back of the box. Through a small door at the side the printing process can be watched. Mr. Roettger, in Philadelphia, manufactures these.

ENLARGEMENT BY DEVELOPMENT.

There are two different ways of obtaining a large positive from a small negative. The *direct enlargement*, and the production of a large negative on collodion or paper, which is well retouched and printed in the ordinary manner.

The small negative which is to be enlarged is placed in the apparatus; the enlarged image is projected on sensitized bromo-iodized

albumen paper. The exposure in the apparatus requires from fifteen seconds to several minutes, in fact until the feeble outlines of the picture appear. The following bath is necessary:

White of egg, beaten to a froth, and cleared, .	100 parts.
Distilled water, ...	1000 "
Iodide of potassium, ...	15 "
Bromide of potassium, ...	15 "

Or,

Serum, ...	1 ounce.
Iodide of potassium, ...	10 grains.
Bromide of potassium, ...	5 "

The paper is floated on this bath for three minutes, dried, and preserved in a closed portfolio.

For sensitizing it is floated for three minutes on the following silver bath:

Distilled water, ...	1000 parts.
Nitrate of silver, ...	70 "
Glacial acetic acid, ...	70 "

While still moist, the paper is dipped in a bath of:

Distilled water, , ...	1000 parts.
Citric acid, ...	4 "
Pyrogallic acid, ...	2 "

The picture develops in a few minutes; it is then placed in a bath of hyposulphite of gold, and left in it for five minutes, and washed.

The composition of the fixing bath is:

Water, ...	1000 parts.
Hyposulphite of soda, ...	100 "
Chloride of gold, ...	½ "

Generally speaking enlarged pictures are inferior in beauty to those which have been taken directly. In America I have seen the best solar enlargements.

MICROPHOTOGRAPHY.

EVERY naturalist knows how tedious it is to draw the enlarged pictures of different objects which we see under the microscope, and how much such copies often vary from the originals.

These circumstances have for a long time induced such men as Bertsch in Paris, Highley in London, Curtis in America, and Kellner in Germany, to employ photography for making pictures of microscopic objects, and they have succeeded in producing splendid "microphotographs."

The process which these gentlemen employ has only partly become known to the public.

Bertsch and Highley used a kind of solar microscope or magic lantern, where the screen is replaced by a sensitive plate. Such apparatus was exhibited in the Industrial Exhibition in London. The price was about three hundred and fifty dollars. Although such apparatus produces excellent results, still its use is attended by many difficulties.

One is compelled to carry the object from the observing apparatus to the photographic apparatus, and it is often extremely difficult to find the place of the object which had previously been observed.

The author tried to dispense entirely with the expensive apparatus, and to take directly the pictures which the observing microscope reveals.

As an example, he placed the mica of South Burgess, which is so curious on account of its Asterismus, on the stage of a Schick microscope, and placed the instrument horizontal. In this position he combined it with a small photographic camera; the latter had a simple achromatic lens (a so-called landscape lens) of about four inches focus. *The two instruments were so placed that their optical axes coincided, and the object glass of the camera almost touched the eye-piece of the microscope.* When, with the concave mirror attached to the microscope, the solar rays were thrown on the object, a clear picture of the crystals contained in the mica appeared on

the ground-glass. With the rack adjustment of the microscope, a sharp image was obtained and a photographic picture taken. The experiment succeeded perfectly, and furnished, after twenty-five seconds exposure, a sharp picture of the crystals, magnified five hundred times.

This method of making microphotographs is so simple that any one can practice it who is at all familiar with photographic operations. It requires no other apparatus than a simple camera with a landscape lens. It can be adapted to any microscope which is sufficiently strong in light, and gives, accordingly as the ground-glass is more or less removed from the object, views which are equal, or larger or smaller, than the directly observed image.

Two precautions should be observed in making such pictures: The lens of the camera must not have a chemical focus, and the picture should be taken in a room which is not exposed to any vibration.

The picture may also be taken when the instrument is placed in a vertical position. In that case the camera must also be placed vertically in order that the two optical axes coincide.

I published this method in November, 1862, and have frequently practiced it.

The illumination offers some difficulty in so far as a quantity of unnecessary light is easily thrown into the object-glass of the microscope, which materially disturbs the purity of the picture. The best way to concentrate the light is by placing the object at the apex of a cone of rays, the axis of which coincides with the axis of the microscope. With opaque objects this danger does not exist. The illumination is made with a condensing lens (bull's eye).

The above stated simple combination of the microscope and the camera has the other advantage, that the cobweb lines are visible in every picture, and that a difference in the chemical and optical foci of the microscope itself does not amount to much, provided that the camera lens is free from this error.

But when the cobweb lines are not necessarily required, we can operate with the microscope alone. The lens of the camera is removed; the tube of the microscope is placed in the opening of the camera; all extraneous light is excluded by means of a cloth, or a sleeve, which is nailed on to the camera, and its other end tied to the tube of the microscope.

When the micrometer screw of the microscope is now gently turned in a direction to remove the object from the object-lens, the image will suddenly appear on the ground-glass as the image pro-

duced by the objective of the microscope is enlarged and projected on the ground-glass by the eye-piece. Unfortunately a chemical focus becomes rather annoying with this method.

By removing the ground-glass further from the object, we enlarge the image.

The extent of the chemical focus is easily ascertained.

I employed a microscopic photograph by Dancer of Konigsberg. The picture itself was an albumen positive, about the size of a pin's head, and placed between thin glass; under a microscope with a power of one hundred diameters, it appears as a plain, legible inscription—the inscription on the tombstone of General Dickson—which is arranged in about the following order:

(1)	To the memory of
(2)	William Francis Dickson,
(3)	Major in Her Majesty's 62d Regiment
(4)	of Foot, and eldest son of
(5)	General Sir Jeremiah Dickson, K.C.B.
(6)	He died a soldier's death before Sebastopol,
(7)	June 8, 1855, having been killed early in
(8)	the morning of that day, whilst gallantly
(9)	holding the quarries against repeated
(10)	attacks of the Russians, &c., &c.

I laid this photograph on the stage of the microscope, not flat, but inclined by placing pieces of wood under one end. The direction of the lines remained horizontal, but the line vertical to it formed with the horizontal plane an angle of 30°. By this arrangement the distance of the lines from the combination of lenses was a different one for each line, and it was not possible to focus sharply more than one or, at most, two lines. With the Schick combination of lenses, 1 + 2 + 3, I focussed sharply on line 8, and took two pictures. On both pictures line 5 appeared black and sharp instead of line 8. This demonstrated a chemical focus. To measure this difference, and to compensate for it, I used the micrometer adjustment of Schick's instrument, by which the stage of the instrument can be elevated or depressed, and by which the fine adjustment is made.

From the above experiments it becomes evident that in order to obtain a sharp picture of line No. 8, I must focus on line No. 5; or if I focussed on line 8, I must turn the micrometer screw until line 5 appeared sharply defined in the field. I have measured the

revolutions, and found that with G. Rose's microscope it amounted to 50°, and with Dove's microscope to 35°, for the combination 1 + 2 + 3.

These measurements are easily made by placing under the head of the micrometer screw a paper circle, which is divided by radii from 5° to 6°, in such a manner that the centre of the circle coincides with the prolongation of the axis of the screw, and by filing on the head of the screw a line with a file. By placing the eye vertical over the head of the screw, it is not so very difficult to note the change on the divided paper circle.

After having measured the focal difference, two new pictures were taken; line No. 8 was sharply focussed, the micrometer screw was sufficiently turned to compensate for the chemical focus, and now line 8 appeared sharp in both pictures.

Another picture of the whole slide placed horizontally and taken with a magnifying power of 25, and the above correction gave a sharp picture of all the lines.

With the microscope the focal difference of every combination must be ascertained by experiment. For low powers the difference is small; a six-fold magnifying power (lens 1 of Schick) shows scarcely any chemical focus.

I would recommend this simple method of ascertaining the chemical focus, not only to persons who photograph with the microscope, but also to all practical photographers. For the latter, a sheet of clear printed matter, placed on a board, will suffice. The board is placed opposite to the camera, not at right angles to it, but at an inclination of from 60° to 70°. The camera is placed at such a distance that the resulting picture is about natural size. The lens is focussed on one of the middle lines, and we examine afterwards which line appears the most sharply defined.

STEREOSCOPIC PICTURES.

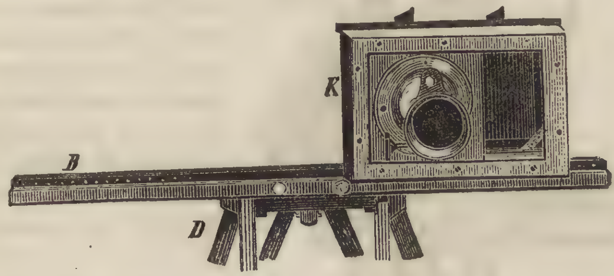
To obtain stereoscopic pictures two different views of an object are necessary,—one a little more from the right than the other, the second a little more from the left.

These pictures can be made (1), the simplest way, with an ordinary camera, which is placed on a stand with a broad top-board. The board, *B* (Fig. 65), is placed vertical to a line which is drawn from the observer to the object.

We either take a camera with a movable plate-holder, with which two pictures can be taken in succession, or we employ a camera

with a movable object-lens and internal divisions (K, Fig. 65). Such a camera is first placed on the right side of the board towards the groove. The right-hand picture is taken on the left side of the plate, looking at it from the rear. Next the camera is placed on

FIG. 65.



the other side from B, and we take the left side of the object on the right side of the plate. That the camera retains exactly the same distance from the object is very necessary, and the board should be placed very firm. The binding-screw, K, of the camera passes through holes bored in the board, or runs in a groove, in order that the position of the camera may be fixed at any time.

The length of the board for distances of about twenty-five feet is about a foot. With nearer objects it is less. With great distances we take four to five feet and even more. When too much length has been given to the board for near objects, they will appear unnaturally solid, while the reverse produces pictures that are flat.

This method will not do for moving or living objects, as these are apt to change their position, and the second picture, even if it should be sharp, would not be in its proper place, and would appear distorted in the stereoscope.

Even in landscape photography this method has great drawbacks, as the illumination will sometimes change between the taking of the first and second picture.

The second method is with a camera with two tubes. With it both pictures are taken at the same time. A change in position or illumination has no influence here, as both pictures are taken simultaneously; but as the tubes cannot be very far removed from one another the right and left view differ very little, and the distances do not appear very solid.

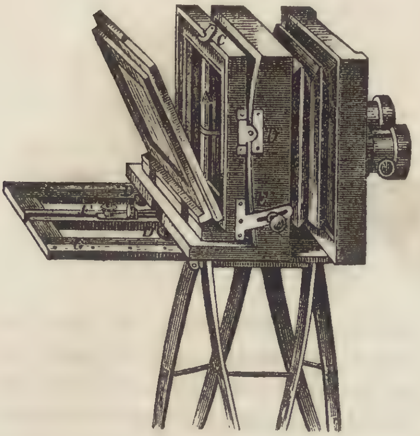
In Germany we use the German and English boxes for this work.

A very practical camera for stereoscopic work is the one called the "Philadelphia Box," made by the American Optical Company,

New York, and one of which was presented me by the Scovill Manufacturing Company.

It consists of a rigid front part (Fig. 66), and the back part *D*, which moves back and forth on the platform. It also has fronts for the tubes. The focussing is done by moving the back part over the brass guides, *G G*, and securing the *exact* focus by using the focussing screw, *F*. The opening and shutting of the tubes is done with a cloth, the common method, I find, in America. Some of the foreign boxes have an instantaneous front, which moves around an axis, and which can be rapidly raised and depressed by turning a knob. The exposure can, of course, be lengthened at pleasure. The whole arrangement fits only loosely on the objective, and is easily removed. The front board with the stereoscopic lenses is also easily detached and replaced by another board carrying a single lens. This same arrangement may be applied to the American boxes when necessary.

FIG. 66.



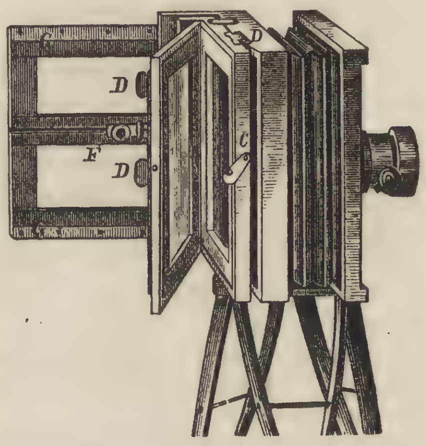
The inside of the camera is divided by a movable piece or diaphragm *A* (Fig. 66), which moves in a groove, and which doubles on itself in shortening the camera, and lengthens when the camera is pulled out, so as always to completely divide the camera into two parts.

Fig. 66 represents the box as it is used for ordinary stereoscopic work. The platform is hinged so that it may fold up compactly; the bellows is rubber; the swing-back, which is indispensable for landscape work, is attached; the front raises and lowers, and the holder is made to fit on pins, which is far preferable to a holder which slides. The ground-glass is hinged fast. Fig. 67 represents the box turned over on its side, for the purpose of making an upright single view with one tube, as recommended by Wilson. The partition or diaphragm *A* (Fig. 66) is removed, so the plate is not obstructed or divided. *C* is a clasp which holds the holder in place when the exposure is being made, and at *E* is a clasp and screw, which keep

the holder at a proper swing or angle when it is necessary to use the swing-back. *G G* are the metal guides; *D D* screws which bind the platform to the box when in use; *F* the focussing screw.

The plate-holders have corners of solid glass on which the sensitive plate rests. Drawings of them will be found on page 47.

Fig. 67.



The lenses which may be used with this camera have an opening of $1\frac{1}{4}$ and $1\frac{1}{2}$ inches, and from $3\frac{1}{2}$ to 6 inches length of focus (calculated from the back lens). They should be provided with stops; the sizes so arranged that with each one twice as long a time of exposure is required as with the next larger one. But stops are only necessary for very near objects. Long distances we can work with the full opening.

The above-described screen for taking instantaneous pictures offers some difficulties. Great care has to be observed that in moving it neither the tubes nor the camera are shaken. The taking of instantaneous pictures requires steadiness and skill.

Lately another instantaneous shutter has been invented, which is warmly recommended by Remele.* It consists of a wooden box which is placed over the tubes. In the box is a curtain which, by being pulled over the tubes, shuts out the light. This can be done rapidly or slowly, as circumstances may require. This arrangement admits also of giving different lengths of exposure to different parts of the same picture; for instance, the sky and distant parts of the landscape may receive a very short exposure, and the foreground considerably more without interrupting the pulling of the curtain-string a moment. With many landscapes for the longer exposure of the foreground, and the shorter time given to the sky, it is of great importance, particularly with distant views. With a lid the illumination would have to be an average one, or the middle parts of the picture would be correctly timed, while the background

* Remele's Handbook of Landscape Photography.

and sky would be completely over-exposed, and the foreground, which generally shows some foliage, would be wanting in detail. By giving a short exposure to the sky the most beautiful cloud effects can be obtained. The pictures which are made with the above curtain arrangement show a beautiful harmony, and many faults in the illumination which we see on other pictures are entirely avoided.

Rouch has constructed a screen for instantaneous pictures which has two shutters instead of one, as in the other arrangement. These shutters turn around a small axis, which is provided with teeth which connect them with a swivel on the centre of the box at each side. It is evident that when the upper shutter is turned with the knob the lower shutter will have to turn also, and that both must move in the same direction. When the arrangement is closed by the upper shutter then both shutters will stand vertical above their axis; when the knob is turned backwards the lower shutter will be depressed, and the tubes will be opened, but will be closed again immediately when the upper shutter places itself in front of them.

The movements of the apparatus are simpler than those of the Dallmeyer instantaneous shutter, but it requires skill and steadiness to operate them.

Braun, in Dornach, manages the opening and shutting of the tubes in a peculiar manner. He closes both tubes with a black cloth which he holds flat in the hand; he removes it rapidly, and replaces it as rapidly again. This movement, however, requires much practice.

For portraiture the lenses should be 2½ inches distant (the distance of the eyes). For landscapes a greater distance is desirable. English mechanics have *placed the tubes on boards which can be moved in a horizontal direction, which admit of their being placed a little closer together or a little further apart.* Of course the shutter arrangement is not always applicable to this arrangement.

All kinds of lenses are used for taking stereoscopic pictures:

1. Portrait lenses, where a quick-working lens is desired (for moving objects, portraits, instantaneous views, &c.).

2. Doublets, aplanatic lenses, correct wide-angled lenses, where correct drawing and a large field of view is desired. Vertical position of the camera is necessary. The tube must have an arrangement by which it can be raised and lowered, in order that the picture on the ground-glass may be centred. By raising the tubes

the sky will become larger, by lowering them the foreground will increase in size.

3. Landscape lenses, where a little distortion does not amount to much.

The methods of operation are in no way different from the ordinary methods. Plates should be selected which are a little larger than the picture is to be. In this way spots at the corners are easier avoided. It should also be observed that plates taken in the double camera show, when seen from the glass side in an upright position, the right side to the left, and the left side to the right. They must, therefore, be cut apart, and their positions reversed.

When this is done at once with the plates it will afterwards no longer be necessary to do it with the prints. When, however, the pictures are farther apart than $2\frac{1}{2}$ inches, which is the ordinary stereoscopic distance, it is better to print them together, and to reverse them when ready for mounting.

The difference in the amount of light in two different lenses is often a great drawback, as they will yield pictures of different intensities, and one is compelled in such cases to stop the one lens until it corresponds in intensity with the other.

INSTANTANEOUS PICTURES.

There was a time when instantaneous pictures were the theme of every-day conversation, and when they gave rise to the most wonderful illusions. The representative Faucher made, in the Prussian Chamber of Deputies on July 1, 1869, the following remarks:

"We have now instantaneous pictures. By this process portraits can be stolen, and perhaps the most extraordinary precautionary measures will be necessary to guard against such a theft; perhaps it will finally be necessary to wear a mask."

These rumors probably owed their origin to the splendid stereos of Braun and Ferrier with walking figures, carriages in motion, horses, &c. The public as well as photographers considered it possible to produce instantaneous pictures in the atelier. Even photographers advertised themselves in the papers as "instantaneous photographers," and very often we heard in those days the exclamation, "Yes, if I had his collodion," as if everything depended on the collodion.

I have already mentioned in another place that the production of instantaneous pictures is only possible under certain favorable conditions: (1) a good collodion; (2) bright light; (3) a lens that

gives a great deal of light; (4) a new and pure silver bath; (5) a strong developer.

But even to this day we hear of instantaneous portraits. "There must be something in it," say a great many; and here we must refer to an episode in the Berlin Photographic Society, when Mr. Ahrens put the question, "What is a photographic moment?" The answer was, "Three seconds."

Of course, instantaneous pictures have been taken in much shorter time than this, but what are they like?

In a good portrait we want modulation. This can only be obtained by a skilful direction of the light, which must not pour in from all sides, but must be excluded here and there.

But this diminishes the quantity of light, and does not suffice for condition No. 2.

On the other hand, clearness in the shadows is demanded; this can only be obtained by long exposure.

Hence, the real instantaneous pictures, taking for instance a space of time not more than one-tenth of a second, are reduced to landscapes with their accessories in clear, sunny weather. And for this purpose we recommend

1. Collodion made by any reputable party, or, when the photographer wishes to prepare it himself, make it according to formula on page 96.*

2. Apparatus—a double objective of short focus giving much light, with an instantaneous shutter.

3. Bath, 1 : 10, freshly made of crystallized silver and one-quarter per cent. of the salt of iodide of potassium.

4. Developer after Remelé: viz., 5 iron, 1½ glacial acetic acid, 100 water (alcohol is not always necessary). Some "instantaneous collodions" of commerce are apt to work foggy with this developer. In that case more acid should be added.

5. Intensifying and fixing as usual. The same conditions apply to taking portraits with a short exposure in the atelier.

To any one who wishes to make instantaneous pictures, I would recommend to place himself in such a position that the majority of the movable objects approach or move away from the apparatus. In this case the change of position is apparently the smallest; in taking a view of a street we should look into the street lengthways, and marching soldiers we should take in the direction of the march.

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* When the following conditions are observed, a less sensitive collodion will suffice.

TENT WORK AND PHOTOGRAPHIC EXCURSIONS.

In the previously described operations, the existence of a laboratory in which the plates are prepared and developed has been considered as a matter of course. But there are plenty of cases where such a laboratory does not exist, and where pictures have to be taken at a distance from the atelier of the photographer. A dark-room has to be prepared before the photographer can commence to work. In case of necessity any inclosed space that can be made light-tight, can be used as a dark-room. Braun, in Dornach, does not hesitate to use cellars, stables, outhouses, &c., as dark-rooms, but it always depends on how far we can work here without being molested by dust or stench. As such a space cannot always be improvised, the travelling photographer will do well to carry his own dark-room along. For such a portable room nothing is better than a tent, which, above everything else, must be light-tight, solid, easily put up, and sufficiently comfortable. As one of the most useful dark-rooms, we can recommend those of Rouch, in London (Fig. 68). It consists, when folded up, of a square box, which, in

Fig. 68.

the annexed figure, is visible as a simple box. When opened, the lid forms the horizontal base of the tent, and the box, the sides. To the latter, the tent cloth, consisting of double black and yellow

material, is nailed; two iron rods are fastened in the box, and the tent cloth is thrown over it; it hangs down as an open bag, in which the operator has to creep. The whole is supported by a firm tripod. The bath is put in a black bag, which descends in front. A square hole, covered with double oiled silk, serves for a window. The best way of arranging this is to make a window which can easily be opened. On the top of the tent a water box is placed, which communicates with the interior by means of India-rubber hose; the latter is provided with a stop-cock. The sides of the tent are best provided with pockets to receive small articles, such as plate-holders, dippers, &c., &c. The base is a folding rubber dish, which has an outlet to the exterior. The tent is placed in a shady place, protected from the wind. In very warm countries sprinkling the tent cloth, and the bag containing the silver bath, with water is an excellent way of keeping both cool.

A similar tent construction, and one which is very solid, is described by Ph. Remele in his excellent Handbook of Landscape Photography. The tent is the invention of L. Herzog, in Bremen. The most essential part of the whole tent is the box necessary for the transport of apparatus and chemicals. The box is opened and four strong wooden legs are attached; on the top a folding iron rod, *a*, is pushed in the corresponding holes and fastened by the rods, *b*, *b*; over the rods a tent cloth is thrown, and with hooks it is fastened to the eyes, *c*, *c*, *c*, above, below, and on both sides. The tent cloth should be double at the sides, that it may be hooked in the interior of the box in a similar manner. At the lower extremity the tent cloth has an opening; the operator creeps into it and ties it light-tight around his waist. At *b* there is a door in the box, which can be opened and shut, and here a window of oiled silk is fixed in.

Fig. 69.

The best material for a tent is the so-called India-rubber cloth; the hooks are fastened to it with gum bands. Overhead a yellow window of oiled silk is placed. This tent is remarkably solid,

offers much space for working, and has, finally, the advantage that one can work in it without wasting a drop of silver or any other solution on the floor.

For excursions all the other objects necessary for operating have to be taken along. I carry a basket with a lid, which is divided in squares; in such a basket all the requisites are easily packed, and the bottles are much less exposed to breakage, owing to the elasticity of the basket, than they would be in a wooden box. Four-cornered bottles are preferable to round ones. The packing of the bottles requires the stuffing in between of some soft material; the best for this purpose is rags or paper. (Tow or hay will make too much dust.)

The following articles are necessary for a photographic excursion:

(*a.*) *For short excursions.*

1. Tent.
2. Camera box.
3. Tripod for same.
4. Connecting screw for 2 and 3.
5. Plate-holder, with frames.
6. Tubes, with camera box fronts.
7. Focussing glass.
8. Plate box.
9. Cleaned plates.
10. Duster.
11. Dipper.
12. Two focussing cloths.
13. Water-can and rinsing-water.
14. Bath or dish.
15. Alcohol lamp.
16. Photogenic lamp.
17. Negative bath.
18. Collodion.
19. Developer.
20. Silver for intensifying.
21. Alcoholic pyrogallic solution.
22. Distilled water.
23. Cyanide of potassium.
24. Some empty bottles and corks.
25. Varnish for negatives.
26. Graduate.
27. Two funnels.
28. Alcohol.
29. Filtering paper.
30. Writing paper for scumming the bath.
31. Matches.
32. Scissors and knife.
33. Twine and pins.
34. Developing glasses.
35. Bottle of nitric acid for acidifying the bath.
36. Bottle of bichloride of mercury* for removing stains from clothing.
37. Towels.

For longer excursions, all the above articles should be taken

* The sublimed mercury is excellent for this purpose, as it does not destroy color

along in duplicate, so that in case of loss they may be replaced, besides,

1. Scales with horn dishes.
2. Weights.
3. Nitrate of silver.
4. Sulphate of iron or sulphate of iron and ammonia.
5. Glacial acetic acid.
6. Pyrogallic acid.
7. Citric acid.
8. Plain collodion.
9. Iodizer.
10. Salts of iodine for sensitizing.
11. Alcohol and ether.
12. Nitric acid.
13. Rags for cleaning.
14. Cleaning vice.
15. Tools (screws, screw-driver, diamond for cutting glass).
16. Permanganate of potash for restoring the bath.

The quantities of the articles must depend on the length of the excursion. For excursions it is to be recommended to test all the mixed chemicals at home, and only to take them when they are in perfect working order. All the articles should be compared with the list before starting, as it often happens that thoughtless people arrive at their destination and have to go home again because some simple article was left behind.

That working in the field or tent requires much more circumspection than in the atelier is self-evident. The difficulties become sometimes insurmountable. Dust, heat, and the want of suitable water, wind, cold, and unfavorable weather. These very often put the patience of the photographer to the severest test.

Another point is of great importance, namely, solid apparatus, which can easily be reduced to a small compass. I will describe some such here.

Meagher's Travelling Camera.—This camera* (Figs. 70 and 71) which was first constructed by a celebrated joiner, consists of a rigid front piece, *v*, which is supplied with grooves for the reception of the board carrying the tubes; the back piece, *H*, *H*, is movable, and receives the ground-glass and plate-holder. The focussing is done by the screw adjustment, consisting of an endless screw, *s s*, and the handle, *g*. The camera board, which carries the whole arrangement, is divided; the back piece, *B*, *B*, is at *x* connected with the front by hinges; a folding support, *S*, with a screw, *r*, gives firmness to the whole. For the transport, the bellows is screwed together, that *H* and *v* touch each other; the screw at *v*

* The same and similar constructions are furnished in America by the American Optical Company in New York, one of whose boxes I have had great pleasure and satisfaction in using.

is loosened, B, B is turned upward, and S is folded on the back. The folding up and setting up of this camera is done very rapidly. The arrangement at H is very peculiar. The ground-glass is neither

FIG. 70.

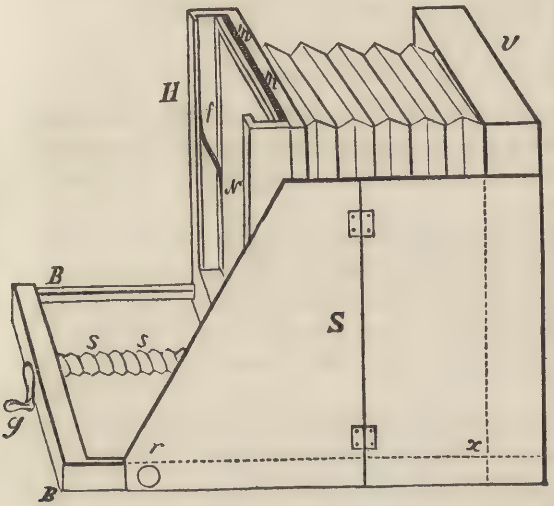
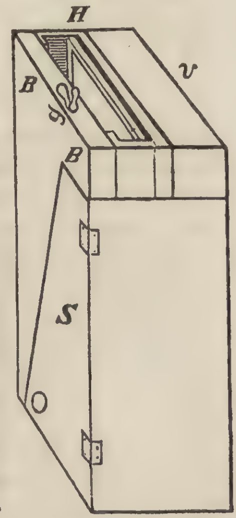


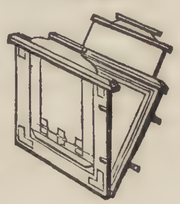
FIG. 71.



removed nor folded back, but the plate-holder is pushed in the slit, m, m; the movable ground-glass, which is kept by the spring f in its place, is pushed back, but immediately resumes its position when the plate-holder is withdrawn. The camera can be used for a focal length of from four to twelve inches, has a movable division in the centre for taking stereos, and one of them served the Egyptian Expedition with best success. The only point to be complained of is the want of firmness of the piece S, which is apt to crack when very dry. Besides the ordinary plate-holder, this camera is provided with an extra one for dry plates. The arrangement is fully explained by Fig. 72.

Travelling Bath.—This bath, which can be bought of any stockdealer, consists of an ordinary glass bath, which is placed in a wooden box, and provided with a rubber covered lid, which by tightening a screw fits water-tight. For short excursions this arrangement does very well, but a long contact of the silver solution with the rubber of the lid is apt to exercise an injurious effect on the bath.

FIG. 72.



The methods of operating do not vary from those which I have described heretofore. On

account of its keeping qualities, I use in travelling the equivalent collodion (see page 96); the sulphate of iron and ammonia for developing and intensifying; for fixing, on account of its more rapid action, and because it requires less washing, I use cyanide of potassium. When the last drop which runs from the washed plate has no bitter taste, the plate has been perfectly washed.

APPLIED PHOTOGRAPHY.

In the previous part of my work, I have explained the operations which are necessary for the production of a negative or positive picture by means of light, without reference to the nature of the object to be taken.

Any one who will follow exactly the directions given, may take whatever object he pleases, and will always get a picture, but very seldom a perfect one. Even the beginner will soon find out that the nature of the object has a great deal to do with success, and that this should not be overlooked when we wish to obtain a satisfactory result.

Let us attempt to copy an oil painting, or a copper plate print, with an exposure which would be sufficient for a portrait, or the reverse; let us apply the intensification which is necessary for such reproductions to a portrait, or let us copy a large drawing with an illumination suitable for a portrait. In either case we will be horrified at the result.

The nature and the succession of the operations remains generally speaking the same, and still every one of them, *pose*, *illumination*, *selection of the model*, *sharp focussing*, *time of exposure*, *development*, *intensification*, must in some measure be modified according to the nature of the object to be taken, and unless we pay strict attention to these circumstances the resulting picture will not be satisfactory.

It is erroneous to think that photography always draws truly. Nothing can be less true than a photograph, when it has been made under circumstances which are not suitable for the object. (See chapter on Æsthetics.)

We must therefore go a little more into detail concerning photographic operations as applied to different objects.

The field is endless. Sun, moon, and stars, animals, plants, minerals, products of art, and products of nature, the microcosmus, and the macrocosmus, all, all belong to the realm of photography. So I am excusable when from the multitude of things I only make a selection. To treat of all exceeds the limit of our work.

I will select those objects the representation of which is principally the work of the practical photographer—drawings, paintings, models, machinery, architectural objects, landscapes, and portraits.

I will speak first of the more mechanical work of "reproductive photography" and the copying of technical objects, and I will reserve the consideration of portrait and landscape photography, which is more of an artistic character, for the second part of my work.

I. PHOTOGRAPHIC REPRODUCTIONS.

(Copying of drawings, prints, oil paintings, &c., &c.)

1. PREPARATION OF THE ORIGINAL.

Care should be taken to get a clean original. A drawing with dirty finger-marks will yield a dirty negative. Lead-pencil lines in India-ink drawings are also annoying, and unequal color of India-ink is objectionable. Photography reproduces everything, the most trifling thing, and the latter very often in an unpleasant degree. Drawings and prints should first be rolled in the press, to do away with the inequalities of the paper. Pictures which are framed under glass should be taken out of the frames, as the glass is apt to produce disturbing reflections of light.

It is well known how much difficulty some yellow prints or spotted drawings will cause. To overcome this, we should resort to retouching the original. Mr. Scamoni, photographer in the imperial printing establishment, at St. Petersburg, writes about it as follows: Every yellowish or otherwise disturbing spot is carefully covered in the spaces between the lines with flake white, and the shadows are wherever it is possible intensified. When the paper is rumpled and not smooth, it should be firmly pressed in a frame against a piece of plate-glass, through which, when it is carefully placed, and with a steady light, very good photographs can be taken. *That the object is absolutely* PLANE *is always necessary, otherwise the picture will show distortion.*

2. ARRANGEMENT.

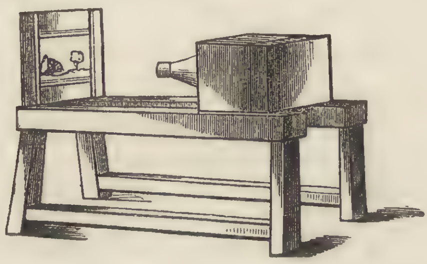
The reproduction of drawings is the simplest of photographic work. Elaborate arrangements are unnecessary. Perfectly smooth stretching on the drawing-board, perfect parallelism between the board, the ground-glass, and the apparatus, are the principal con-

ditions of success. When these conditions are not observed, distortions in the drawing will necessarily be the consequence. The lines, which are parallel amongst themselves, converge towards the top or the sides, when the apparatus, instead of being absolutely vertical to the axis of the drawing, is turned a little upwards, or downwards, or sideways.

To secure this parallelism in the position, larger establishments have made arrangements to keep drawing-boards and apparatus always parallel to one another.

Such an apparatus (Fig. 73) consists of a strong support, which rests lengthways on four or more feet. On one end the drawing-

Fig. 73.



board is attached at right angles to the metal guides which are fastened to the sides of the support, and along which the camera moves. When necessary, one end can be left open to admit the operator for the purpose of focussing, and the support can be made rigid by uniting the feet near the floor, and strengthening the guides on which the camera moves, by iron braces. On the copying-table, in the Royal Technical Institute, in Berlin, the drawing-board is moved by cords, which run over rollers underneath the camera.

The drawing-board should be divided into square inches, which, combined with the square inches which are marked on the ground-glass, will be a great help in determining whether the picture is exactly square and of the right shape, and it affords at the same time a means for determining the proportion, whether $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{4}$. It is also very practical to provide this apparatus with a scale at the sides divided into inches, by which the distance between the drawing lens and ground-glass can be determined beforehand. The distance (with a given lens) necessary for making a natural size, double natural size, or half size picture, can be marked down once and forever, and all the trouble of finding out the position is avoided in the future.

The dimensions of these supports must necessarily depend on the extent of business of the atelier. It must be observed that for natural size drawings, the ground-glass must be removed from the lens the distance of twice its focal length. Smaller supports of this kind should be placed on rollers, as it facilitates their removal from place to place.

In an atelier where reproductions are an exception, simpler arrangements will answer every purpose.

In this case the drawing is simply placed on a stand as described (page 42), and the camera is placed opposite. The distance necessary for getting the correct size of the picture is first found approximately; next the board and camera are placed as nearly *vertical* as possible by placing the sides exactly parallel with some vertical architectural part, as, for instance, the corner of a room; finally, to get the camera and board parallel to one another, the lines of the boards of the floor will serve as guides. It requires some patience, but the result is better than with a spirit-level.

With oil paintings a different course has to be taken; to avoid glaring reflections, they have to be inclined forward in the same way as they are generally hung on the walls of galleries.

3. ILLUMINATION.

For copying of drawings, the illumination is of the simplest kind; nothing is necessary but an even light over the whole surface. This takes place only when the angle of light is nearly the same for every point of the picture. Any one who has studied the principles of illumination, as laid down on page 27, will easily satisfy himself on this point. A front light, which passes over the camera on to the drawing, is the best. Care should be taken that the camera does not throw its shadow on the drawing.

Sometimes the paper is rough; each fibre or each depression will cause a shadow. When this is the case, the drawing should, if possible, be passed through the rolling press, or else a sheet of white paper should be laid in front of it and used as a reflector.

More annoying than unevenness is gloss, as with varnished pictures, and particularly oil paintings and photographs. The easel with the picture should be placed where this disturbing reflection does not appear. Opening and closing of the curtains sometimes gives material advantages. To be quite sure that it does not disturb, the eye should be placed in front of the lens and the picture examined. This will show the exact effect of illumination. Oil paintings are placed at an angle, as stated above; the axis of

the apparatus is placed vertical to its surface. Sometimes direct sunlight is of advantage, particularly when age has darkened the picture. The illumination should be so arranged that, besides the gloss, the shadows of heavy layers of paint are avoided.

4. THE LENS.

All kinds of lenses are used for reproductions. With art subjects, copper-plate prints, oil paintings, a slight distortion does not matter much, particularly when only the central part is used. For mathematically correct pictures, however, an absolutely correct drawing lens is required, and as such a one I recommend the Steinheil Aplanatic Lens, or the Ross Doublet (see page 72).

Portrait lenses which have a great deal of light are only necessary for dark oil paintings to shorten the time of exposure. Objectives of feeble light, as the pantoscope (which also draws correctly), can only be employed with a bright light.

With the full opening, the lens is focussed on the centre of the picture (with Steinheil lens), or half way between centre and margin (with the Doublet lens); after this has been done the stops are inserted. For line drawings, a stop should be used so small that the picture is sharp to the edge. For oil paintings, larger stops should be used, to gain light.

5. PROTECTION OF THE OBJECTIVE AGAINST FOREIGN LIGHT.

This protection is absolutely necessary for drawings, where it is the object to obtain clear lines. A black box, and a piece of pasteboard in which a hole has been cut, just large enough to show the drawing, but excluding everything else, is placed in front of the lens. A wide tube placed over the objective, in which another tube moves, like a telescope, is also of advantage. Landscape lenses do not require this protection as much as portrait lenses.

The whole field of view of the lens should not be used, as this would expose one to a considerable loss of light towards the margins.

6. TIME OF EXPOSURE.

The correct time of exposure is not so easily determined in *reproductions.* We must distinguish between black line drawings without half tones, copperplate prints, and pictures with half tone. When the former are exposed too short a time, the picture develops slowly and looks pale; all the lines are transparent, and

it requires long intensifying, and the film is apt to become brittle and to split. When the exposure is too long, the black lines will finally exert some action, and will appear, after development, *weak* and *foggy;* they will print *gray* instead of black. Generally speaking, in line drawings, over-exposure is worse than under-exposure; just the reverse from landscape or portraits.

Drawings with *half tones* require longer exposure than line drawings, in order to get details in the shadows. Drawings with *half tones* and *lines* give the greatest difficulty. When we expose for *half tones*, we get partially veiled lines; when we expose a shorter time, the lines will be black, but the half tones will be hard, and the shadows will be wanting in detail. Of the two evils, we should choose the least. Draughtsmen, who work for photographers, should accustom themselves to drawing with deep black lines on white paper. Gray lines give the most trouble; for instance, the glossy lead-pencil line. Copperplate prints also cause some difficulty; generally they are only medium black, and we often get copies which are blacker or weaker than the original.

To copy oil paintings correctly was formerly considered an impossibility. The colors, of course, cause much difficulty; a sun of chrome yellow will appear as a black spot, an ultramarine blue sky will appear white, not to speak of other colors. The most obstinate color is brown, and brown photographs are only with great difficulty reproduced. Fortunately the reflected light from the colored surface acts a little, but generally speaking a longer exposure will be necessary with oil paintings than any other pictures when we wish to get detail in the shadows and in the inactive working colors. Every picture should be examined most carefully after development. When the details in the shadows are insufficient, the time of exposure should be increased; sometimes this does not insure success with such colors as umber and dark green. Under these circumstances nothing remains but to replace the missing tones by negative retouch. Clouds and sky have often to be strengthened by negative retouch, as they will be visible in the negative, but do not offer sufficient contrast. In regard to the technicalities of negative retouch, I would refer to the chapters on that subject in the splendid work of Mr. Ayres, entitled "How to Paint Photographs."

7. METHODS OF OPERATION.—FORMULÆ.

The different operations should be carried on with the formulæ given above. For half tone pictures and oil paintings, I use a

strong developer; for line pictures, I take a feeble developer (see page 98).

For long exposures particularly, precautionary measures are necessary. The repelling action of the collodion film is very apt to produce marbled stains. Collodions from which the bath runs off in greasy lines are not suitable for long exposure. On the other hand there are "moss stains" caused by particles of dirt from the plate-holder which become imbedded in the film, and finally drying spots, by actual drying of the silver solution on the plate, in which case the iodide of silver is dissolved by the concentrated bath.

To prepare wet plates for a long exposure, Carey Lea recommends, in the "Philadelphia Photographer," the following:

1. Marbled stains, which show themselves particularly in the centre of the plate, are best avoided by dipping the plate into the silver bath immediately after collodionizing.

2. Spots, which in spite of these precautions will appear, and particularly at the lower corners, are best avoided

a. By the use of two baths—an old one for sensitizing, and a new one for dipping the sensitized plate after it has been taken from the first bath.

b. By placing a thick strip of blotting-paper, which is bent over lengthways in such a manner that one part is about one-eighth of an inch wide, and the other one inch wide; the part which is one-eighth of an inch wide is placed under the plate, when it is placed in the plate-holder, in such a manner that the plate rests on the thick and narrow layer of paper. The wider part is then placed on the back.

To keep the plate-holder clean is a matter of course. By following these directions an exposure of half an hour or more is possible.

Covering the back of the plate with wet blotting-paper, and employing a spongy collodion, rich in bromine, is also a remedy which is to be recommended.

Jabez Hughes recommends, besides *the above-named remedies*, the employment of *washed wet plates*. The plates, after they have been sensitized, are placed in a large dish with *very pure distilled* water; they are moved for about three minutes, the superfluous water is allowed to drip off, and then they are used. Before development they are returned to the silver bath, and moved in it for at least one minute.

In the development, the rapid or slow appearance of the picture is a criterion whether the picture has been over or under-exposed. Intensification is, particularly with line drawings, a point of *great*

importance. The plate must be intense enough to offer a considerable obstruction to the passage of light, otherwise we will get a reproduction in which the ground is gray instead of white.

Photolithographers and photogeographers require very thick and opaque prints. For this purpose Waterhouse recommends the following method of intensifying: After the solution of pyrogallic acid has been completely removed, the plate is dipped into a saturated solution of bichloride of mercury, and remains in it until it appears almost white (like porcelain); as soon as glossy lines appear, the operation should be stopped, and not be carried beyond a dark gray tone. After this the plate is washed, and a solution of sulphate of ammonia is poured over it, which changes the color into a reddish brown, verging on black. When the plate has been well washed, it is varnished in the ordinary manner.

After many experiments in India, I found that when citric acid has been employed in the developer, the film shows great inclination to split as soon as the plate is dipped in the bath of chloride of mercury. I tried to find a substitute for the mercury bath, which, for many reasons, is unpleasant. I employed the following formula, recommended by Mr. M. Carey Lea:

Cold saturated solution of bichromate of potash, .	3 fluid drachms.
Hydrochloric acid, ...	1 drachm.
Water, ...	6 ounces.

This solution is poured upon the plate after it has been intensified with pyrogallic acid. The color of the film changes rapidly into a splendid lemon-yellow, and the lines seem to become a little clearer. When the solution has been removed by washing, a solution of sulphate of ammonia is employed, and this changes the color into a deep chocolate-brown.

The only point which requires particular attention is the washing of the plate after each operation, for when this has been neglected the lines will run together, be covered with precipitates, and the negative will be spoiled.

8. THE PRINTING.

Perfect negatives will print easy, and do not require any artificial help. The printing is carried a little into excess, that the high lights may show a little color. In toning, the high lights will become white. Negatives, in which some parts are too thin, others too thick, have to be copied with a mask. The thin parts are copied first; when ready they are covered with suitably cut pieces of paste-

board, and the dense parts are printed until they reach the necessary amount of color. The tone of the picture should be kept very black by employing an alkaline or chloride of lime bath. See page 139.

9. CRITICISM OF THE RESULT.

To judge of the result, the severe and critical comparison between the copy and the original is not very difficult with drawings and prints, as both are monochromatic. It becomes more so with oil paintings. With these the effect of color has to be reproduced by the mere graduation of tone between light and dark. We have to observe at the start that in photography the cold colors (blue) are reproduced too light, while the warm colors (yellow and red) are rendered too dark. This contrast has to be equalized if the picture is to be true. We have, so to say, to analyze the colored original. We have to ignore the color, and have to observe what should be light, half shadow, and dark; what should be prominent and what not.

When, in a photograph, the proper gradation between light and shade is wanting, the figures will not separate; the picture, in short, lacks character, and is worthless.

Whoever wishes to photograph works of art correctly must be an artist himself, or else submit to the superior judgment of an artist.

There are hundreds of reproductions of oil paintings in the market which show light where the original is dark, and *vice versa;* or where the several figures which in the original are properly separated by contrast of color, appear in the copy as an undefined mass; or large surfaces show nothing but shadow where the original is full of delicate detail. All these several points have to be observed, and only by exercising a sound criticism can a satisfactory result be secured. Oil paintings, which have become dark by age, and in which the eye does not recognize any details, of course cause more difficulty than new ones.

Reproductive photography is a branch which stands on the border between the purely mechanical and artistical activity of the photographer. So far as it is based on artistic principles, it belongs to the chapter on Photographic Æsthetics; practical considerations induced me, however, to treat of it in the purely technical part of my book.

II. PHOTOGRAPHING OF MODELS, ORNAMENTS, STATUES, WORKS OF ART, MACHINERY, ETC.

1. PREPARATION OF THE OBJECT, AND ARRANGEMENT.

It is difficult to find general rules for the parti-colored medley of objects which have been arranged in this chapter, as these have to be modified by every especial case, and I will only try to develop those principles which one dare not neglect in taking the picture of such objects as are placed at the head of this chapter.

The rules which are laid down for reproductions also hold good here. Everything which does not belong to the object-proper should be removed, and no pains should be spared to make the object as elegant as possible before proceeding to the taking of the picture.

The objects which come under this head are either easily removed (can be transported to the atelier) or not. The latter have to be taken at the spot where they are located, with all the accidental surroundings—landscape background, spectators, &c.; sometimes with an unsuitable or even impossible illumination—in dark cellars, &c.

Objects which can be placed in the atelier are best placed in front of a monotonous background (see page 40). According to the nature of the object different shades are necessary. As a general rule, we may state *that the object must contrast with the background.* They must not be equally light or dark. It will be observed that the background becomes darker by moving it away from the object. This enables us to make a completely black background on the picture with a screen which naturally is only gray. A background which is too dark can be lighted up by a suitable illumination. As a basis we should select a dark table or a support of a sombre color. *All other things should be removed.* A vertical position is almost a matter of course. The selection of the position of the camera is of much importance. The camera has to be placed at the spot where an expert, but not a photographer, would place himself to get a full view of the whole object. The direction in which the camera is placed should correspond with the direction of the eye of such an observer. It is therefore necessary that the photographer should perfectly know his subject if he wants to select the proper standpoint. Of what use is the most brilliant picture of a piece of machinery when the main things are hidden by secondary matters. Sometimes this may depend on a single wheel or a single screw. It is the same with objects of art. The pho-

tographer has to study his subject, exactly as the actor has to study the character which he is to represent.

Whoever wishes to take pictures of plastic figures must understand the plastic; he must be possessed of artistic judgment, or he will commit gross errors.

The same holds good for technical objects, as stores, machinery, tools, and reliefs. Any one, not being an expert in these matters, should at least consult some one who understands it thoroughly. In taking works of the plastic art, he should consult the sculptor; in taking technical objects, he should consult a mechanic, who will point out to him which parts are essential, and which are not. The engraver has to do the same when he desires to make an engraving of an intricate piece of machinery.

The advantages of photographic pictures of technical objects have often been estimated as being of very little value. The reason is that the pictures were made by photographers who did not understand their subject. Not photography but its disciples are to be blamed. My space does not permit me to give detailed instructions to every one who wishes to photograph statues, or machinery, or architectural objects. Fortunately our literature is not deficient in such works, and it is the duty of every one to instruct himself in these matters.* The cultivation of these specialties is the reason why we have nowadays portrait photographers, landscape photographers, and architectural and technical photographers. The practical manipulations are nearly always the same; but the particular success in any one of these branches is based on particular knowledge of the subject-matter. It is not unusual to find that a skilful portrait photographer will make a poor hand at landscape photography, and a good worker at reproductions will fail completely in portraiture.

When the proper side from which the picture should be taken has been found, the distance is the next important subject. When the camera has been placed too near, perspective exaggerations are apt to take place; even with the best of lenses the nearer parts appear too large. When the camera is removed too far, the relief is apt to seem too flat. The photographer will be very apt to make the *former* mistake from *want of distance*, and (when working in a contracted space) he often has no other choice. Vertical position of the camera is generally necessary, particularly when taking technical objects (models, &c.). Under certain circumstances, however,

* We would recommend Lübke's History of Architecture, also Lübke's History of Plastics.

an inclined position of the camera has to be selected. Take, for instance, a statue on a high pedestal, which we are accustomed to see from below, and which has been constructed by the artist with reference to this position. It would be absolutely faulty if we would copy such a statue in the atelier on a level with the camera. On the contrary, it should be placed high, and the apparatus should point upwards; by doing so we will only conform to the natural conditions for which the statue has been constructed. We know works of art, as, for instance, the George's Head, by Kiss, which, when seen from a level, looks indifferent, and only makes a startling impression when viewed from below.

We often sin against these principles. Portrait photographers, who are accustomed to incline their cameras on the sitter, too frequently apply this position for all other objects. I would here call the attention of the photographer to what will be said in the article on PERSPECTIVE.

2. ILLUMINATION AND EXPOSURE.

The selection of the proper illumination is as important as the selection of the proper standpoint. Artistic objects require analogous considerations to portraits (see Æsthetics); technical objects must appear distinct in all particulars; dark shadows, which are apt to obliterate some details completely, should be avoided. The light of a high atelier, which pours in uniformly, is preferable. Objects which have to be taken in a given locality can of course not be brought into a suitable illumination. We have to wait for the suitable moment, and very often we have to assist with mirrors, magnesium light, or other artificial means.

By the aid of a mirror sunlight is thrown on the object (it is best to follow the direction of the camera); and by slightly moving the mirror the light is passed to and fro over the whole object. Objects which are much hidden can often only be reached by two mirrors, and the light proceeding from the first has to be caught by a second one, and is from it reflected on the object. Of course, with such a process, much light is lost. The time of exposure, for such an illumination, in July, with a Steinheil lens, and third largest stop, is, with a single mirror, about six minutes; with two mirrors, from nine to twelve minutes; the object being dark.

The following principles of illumination and perspective refer to all objects. The specially noted lifeless models are very different in their character; sometimes purely artistic, as plaster models,

marble figures, &c.; sometimes purely technical, as models of machinery; sometimes of a dark color (cast iron); sometimes white (plaster of Paris).

How extremely different the treatment of such bodies must be is self-evident. A white figure requires a dark background, a dark one (bronze or iron) requires a light one; the former a short exposure, the latter a long one. Remember, too, that high lights often make their appearance on metallic objects, and require to be modified by suitable illumination, or by dusting the respective parts with gray chalk. Still more annoying are colors; very often we have to distinguish between red cast (copper) and bronze; both act photographically alike. We must resort to negative retouch for separating parts which should be kept apart, but which will run together on account of color.

For taking buildings in the open air, a light falling from the front at an angle of 45° is the most advantageous. The exposure should be continued until all the details in the shadows appear.

3. LENSES.

In the selection of lenses *freedom from distortion* should be looked for. For objects that give out very little light, portrait lenses should be used; where correctness of drawing is the main object (machinery), *doublets* or *aplanatic lenses* are the best; with a large angle and short distance, the *pantoscope* is preferable. I repeat that acquaintance with the object is necessary for the proper selection of the lens. The same refers to stops.

It is advantageous to place over a piece of machinery white graduated marks lengthways, perpendicular, and horizontal; they should be included in the photograph, as with a knowledge of the perspective the dimensions can be reduced from them.

The negative and positive process are practiced according to the rules given in previous chapters. A strong developer, however, should be used.

THE ART OF PHOTOGRAPHY,

OR

PHOTOGRAPHIC ÆSTHETICS.

The photographic pictures, which are obtained by the previously described processes, are made for very different purposes. They are either of a purely scientific or technical nature, such as pictures of microscopic objects, representations of machinery or buildings, architectural plans, &c. In such cases their object is to instruct. Again, a real practical use is made of them when they furnish the basis for measurements, when used as aids in the construction of maps, or when buildings are erected according to the delineations which they represent. Finally, some of the pictures obtained are of an artistic nature, and then they have no other object than the one to please; and amongst representations from nature we have to class portraits and landscape pictures in this category.

The question whether photography is an art or not is an idle one. Experience has demonstrated that a sharp and spotless, or in short a technically perfect photograph, be it portrait or landscape, may appear on the one hand untrue, or it may displease when the observance of the laws of the beautiful (which are the cause of our pleasure in the works of the plastic art or paintings) have been disregarded. That these laws in their generality are not applicable to photography, which more than any other art is "glued to the substance," is evident.

The photographer cannot follow his mind's ideal flight. The children of his creative fancy enchant us not in marble, nor do they charm us with brilliant hues on the canvas, but his aim is to portray nature; and the most which can be demanded of him is a beautiful reality,—truth in a pleasing form.

Let us see now how nearly photography gives us truth.

PHOTOGRAPHY AND TRUTH.

Admirers of photography assert so often that this young art represents the pure truth, the true counterpart of nature. Photography can, indeed, when rightly applied, produce truer pictures than any other art, but they are not absolutely true, and because they are not absolutely true it becomes important to learn the sources of error, and they are manifold.

Let us first consider the optical errors.

A picture which has been taken with a lens that does not delineate correctly, and causes the marginal lines which should be straight to appear curved, can certainly not be called a correct one. Many persons may not notice these distortions, nevertheless they exist. Some will say that a correctly drawing lens will avoid these errors. True, very true; but let us examine the pictures of high buildings which have been taken with such a lens from a low standpoint.

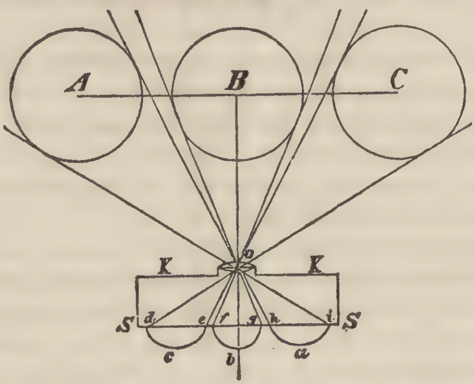
The lines which should be vertical will converge towards the top. Can this be called correct? But you will say the reason of this is that the camera was not placed level. Very good; but let us now try a Globe or pantascopic lens, and take a view of a long street: how the perspective deepens; how enormously large the nearer houses appear, and how very small are the objects in the distance. Houses that are a hundred feet distant look as if they were half a mile away. Is this truth? No, certainly not; and yet the lens draws correctly, the camera has been placed exactly on a level, and the perspective is mathematically correct. A draughtsman could not make it any better.

But where lies the mistake? The angle of vision is too large. Unfortunately, this cannot always be avoided, and curious enough it affects straight lines as well as curved ones. Take, for instance, a pile of cannon-balls. An artist would represent the balls circles. Now take a picture of them with a wide-angle lens, in such a manner that they will appear at the edge of the picture, and instead of circles we will have ellipses. Mathematically, this is easily explained. From every ball (*A B C*, Fig. 74), a conus of rays proceeds to the optical centre of the lens, *o*, and the plane of the picture intersects them as an ellipse, when it falls in any other direction but at right angles (see the chapter on perspective).

A photographer showed me the view of a castle which had been taken with a Globe lens. In front of the castle was a row of statues, and it was really comical to notice how the bodies and faces grew

broader towards the edge of the picture, and the slender Apollo de Belvidere, who unfortunately happened to be at the extreme edge of the plate, had such a broad face, and his body showed such a remarkable rotundity, that he looked like Dr. Luther.

FIG. 74.



Now, is this truth? Unfortunately these are not the only sources of error; there are a great many more.

Further on in this book, I publish four heads, portraits of the same person. They were taken by Loescher & Petsch, of Berlin, with front-light, top-light, side-light, and oblique-light. In the first picture the man looks dull and stupid; the second gives him an angry and savage expression; the third gives him a cunning look; which of the three named pictures is the true one? Not one of them. The truest representation is No. 4, where a combination of light effects has been employed, and we see that the mode of lighting can also become a source of error. This not only holds good for portraits, but refers to landscapes also. The view from the Rochusberg, in Bavaria, had often been described to me as most beautiful. Accompanied by friends, I visited the spot several times, but we could not see any beauty in the view. At last I visited it again, not as before in the morning, but in the evening, and then the view was charming. But besides the direction of the light being a source of error, there is another circumstance which has much influence on the correctness of photographic pictures.

Generally speaking *the lights are too white and the shadows are too black* in photographic representations. This is a radical error, which has its origin in the nature of the art, and the avoidance of which becomes sometimes very difficult. The error is most strik-

ing in taking the picture of an object on which the sun shines with full force, for instance a statue. If we expose for a short time only we get the details of the light parts, but the shadow is a black spot without any design. If we expose for a long time we will get some detail in the shadows, but the lights will be over-exposed to such an extent that all the finer shades will be missing. Is this truth?

These are the reasons why we have so much difficulty in our studios when we wish to produce a properly lighted picture. We keep the lights more diffused and the shadows lighter than what painters would do, and the latter are often surprised when they see a model in the gallery, under such artistically faulty illumination, yield a picture correct in lights and shadows.

In taking landscapes, architectural objects, and particularly interiors, we cannot control the light with the same ease as in portraiture. I once photographed a chemical laboratory. The room was large, with an arched ceiling. In the picture you can see the tables, furnaces, retorts, lamps, &c., everything perfectly plain except the arched ceiling; this was too dark.

I made other attempts with twenty, thirty, and even forty minutes' exposure; at last I saw a trace of the ceiling, but now the objects near the windows were so much over-exposed that all the details were lost. The result was four pictures, not one of which was true. Finally I resorted to throwing reflected sunlight on to the ceiling.

This circumstance, that photography reproduces the dark parts too dark, makes itself felt in very simple operations, for instance in the reproduction of prints. A photographer reproduced Kaulbach's "Battle of the Huns." The copy was an excellent one, but the background was too dark, too thick, not hazy enough. The copy was refused, and another picture demanded.

The photographer now gave a longer exposure. The background had the hazy appearance of the original, but unfortunately the figures in the foreground, which should have been bold and black, had a dusky gray look. Is this truth? The artist succeeded finally by retouching the negative.

I have purposely selected simple examples to prove my assertion, that it is difficult to make truthful photographs. But now comes the worst point of all, the different colors. In photography the cold tones will be rendered too light, while the warm ones, such as red and yellow, will be reproduced too dark. As an illustration I may mention the photographic copy of Hildebrand's painting,

"Sunset on the Ganges"—a glowing red sun with burning clouds of chrome yellow on an ultramarine blue sky. And now what does the photograph show? A black disc surrounded by black thunder-clouds. The sun looks like the solar eclipse at Aden. Is this truth? Still more striking becomes the lack of truthfulness in photography when the artist attempts the solution of a higher artistical problem. Perhaps the reader knows the pretty little picture called "A Mother's Love." A young mother, in modern costume, sits in an arm-chair reading; her little son approaches from behind, and, standing on a chair, embraces her. Surprised and delighted the mother drops her book and kisses the child.

A photographer took it into his head to reproduce the picture from living models. He easily found a pretty girl suitable to represent the mother. A boy, a chair, some decorations, and furniture, were not hard to procure, and the group was placed in position. The mother in effigy readily complied with the directions of the artist, and made a face which perhaps might express motherly affection. The boy, however, had different ideas. He did not feel himself drawn towards his pseudo mother, and protested energetically against any familiarity. It required a good, sound thrashing to bring him to terms. With these preliminaries time had been lost. The mother begins to feel uncomfortable in her forced position, with the head partially turned backwards, and finally the photographer "fires away." The picture is sharp, fully exposed, without spot or blemish. The models, to their great joy, are discharged. A print is made, and what is the result? The boy embraced the mother with a face in which the thrashing is plainly visible, and with a look that seems to indicate a desire to choke her, while the mother looks much more like saying, "Charley, you are very naughty to interrupt my reading," instead of "Dear little pet." Can any one say that such a picture expresses the intention of the photographer? Is the above-described an expression of the title "A mother's love?" Any one will fail to see the intention of such a picture. The whole, although a true copy of the group as placed before the camera, is, as an expression of a mother's affection, a photographic lie.

Such pictures we find by the thousand. Ten years ago these sins were committed over and over again by the makers of stereograms, and when such pictures meet with approval we can only blame the corrupted taste of the public for it. But it will be said that the photographer cannot be blamed for the lack of truth in such a picture. His models should be censured for it. Still it is

the fault of the photographer. Pictures in which the models do not absolutely come up to the intentions of the artist should not be made at all. They do not lie within the province of photography.

But there are other characteristic cases of photographic untruth for which the models cannot be blamed. Stimulated by the beautiful pictures of Claude, Schirmer, or Hildebrandt, a photographer attempts to take a sunset. Of course the brilliant glowing sun requires only a very short exposure; what kind of a picture will he get? A round, white spot surrounded by some glowing clouds will be all that is visible. All the objects in the landscape—trees, houses, men—are all totally under-exposed. The road, the village, the wood, and the meadow, all so beautiful to the eye, are nothing but a confused black mass without any outline. Is such a picture true? Even the enthusiast in photography will not dare to say yes.

Cases where glaring contrasts in light and shade make the production of a true picture impossible are very numerous. Most of the photographs of the Royal Monument in the "Thiergarten" belong to this class. The monument is beautiful, but the background of the trees is without detail, without half tones, an undefined mass, anything but a representation of the splendid foliage which charms the eye at this spot.

Still more numerous are the photographs of rooms, where the corners in which objects are plainly visible to our eye are represented by pitch-dark night. Other cases of photographic untruth are still more characteristic.

Observe that mountain scene. A village inclosed on either side by wooded hills occupies the middle ground. Houses are picturesquely scattered amongst the trees on the hillside. A chain of finely-curved mountains in the distance, the peaks of which are glowing in the evening sunshine, forms the background of this wonderful picture. Only one thing is annoying. A dilapidated pigsty, and next to it a heap of straw, are in the immediate foreground. A painter who would paint this picture would either omit the objectionable feature altogether, or keep it so subdued that it would barely be noticed.

How is it with the photographer? He cannot remove the sty. He looks for a different standpoint; but now the trees cover a large portion of the landscape. He takes the view, sty and all, but what kind of a picture will he get? The sty, which is in the immediate foreground, on account of its proximity, appears of gigantic size. The distant landscape, the *main object*, is small and insignificant.

Still worse is the effect of the pile of straw in front of the sty. It occupies one-fourth of the whole picture.

Being the most brilliant object in the whole picture, it draws at once the eye of the spectator and calls it away from other more important points. The effect is unpleasant. It annoys the photographer, and does not appear to be a representation of the landscape for which it was intended, but a picture of the pigsty. The secondary matter has become the main object, and if any one writes under such a picture "A View of Dornburg," it is simply untrue. It is untrue, not because the objects represented do not exist in nature, but because the secondary matter is represented too plainly, too glaring, and too large, and the principal objects appear dim and unimportant.

We now touch a sore spot in photography; it draws the main objects and secondary matters with equal distinctness. To the plate everything is indifferent, while the true artist, in producing pictures of nature, will give prominence to the characteristic points, and subdue and moderate the secondary matters. With artistic freedom he can act and do as he feels best, and he is fully justified in doing so; for as he gives the characteristic points only, and suppresses what is secondary, his work will appear more true than photography, which reproduces everything with equal distinctness, and sometimes gives the greatest prominence to the most trifling matter.

Reynolds, in speaking of the portrait of a lady, where an elaborately painted apple tree forms the background, says, it is the picture of an apple tree, and not of a lady. The remark is applicable to a great many photographs. It is a cardinal fault that they elevate secondary matter to the most prominent position. We see a conglomeration of bright furniture, and only on close inspection we will find that a man is placed amongst it, for whose portrait the picture is intended. We notice a white-spotted dress, and finally discover that it belongs to a girl whose head is just visible. We see a park with fountains and other fixings, and on very close inspection we notice the black coat of a man dimly contrasting with a piece of dark shrubbery.

Perhaps some will raise a great outcry when I ascribe greater truthfulness to the unrestrained art of painting than to photography, which generally is considered the most truthful of all the picture-producing methods. That I refer only to the works of first class artists is a matter of course, and it is one of the greatest merits of photography that it has made the daubs of art, which were for-

merly sold at every corner, an impossibility. I consider it my duty to call attention to the sources of untruth in photography. Only when we have learned to know them, and to appreciate them, will we learn also to avoid them; and those who have been taught to watch for them feel surprised and astonished how problems of the most simple nature offer difficulties in regard to truth.

It is the duty of the photographer to weigh well the difficulties which he has to encounter in the production of a truthful picture. His picture to be true must give prominence to the characteristic points, and such as are secondary must be made subordinate. The insensible plate of iodide of silver cannot do this. Controlled by immutable laws, it delineates everything that is presented.

The photographer accomplishes his purpose partly by a suitable preparation of the original, partly by a proper treatment of the negative. It is necessary, however, that he should know the characteristic and secondary points of his model. He that has not got an eye for these is not a photographic artist.

As the sculptor and painter, in order to produce a life-like and beautiful picture, must pay attention to the minutest details of every feature of the face, every effect of light and shade, every fold in the drapery, so must the photographer study his model as closely as possible in features, carriage, and dress. The forte of the two arts, painting and photography, is however entirely different.

The object of both is to produce a beautiful picture on a plane surface, which must not appear flat, but round and real.

The painter can produce upon his canvas from an imperfect model an artistically beautiful picture, and improve upon the original by idealizing. The photographer has to work differently. He cannot, like the draughtsman, make changes in his picture (a few trifles excepted). To secure beauties in his picture, they must be present in the original. It is therefore his object to beautifully pose and light his model, and in short to arrange a living picture. Not until this has been done is the mechanical process put into operation. It is by no means true that only beautiful originals will furnish artistically perfect pictures. Every original has its faults. The photographer must reproduce his original from the point where it shows the least faults, or he must cover them by artifices. If he fails in this, the very best of chemicals, apparatus, and formulæ, will fail to produce an artistically beautiful picture.

ON LIGHT AND ILLUMINATION.

LIGHT is the element of life, the drawing-pencil of the photographer. It is the brush with which he paints. For him a thorough knowledge of this element is as important as it is for the painter to possess an exact knowledge of his colors.

At present it is our object to explain the æsthetic principles of illumination.

Like the painter or draughtsman the photographer has for his purpose the production of a picture on a plane surface which shall give the beholder the impression of a reality. The figures must not appear flat like the paper which bears them, but plastic, with foreground, middle, and background.

There are two ways of producing this apparent solidity. The first of them is by means of *perspective.*

All objects of equal size appear smaller in nature when seen at a distance; the draughtsman, bearing this in mind, decreases the proportions of his figures with the distance. He succeeds thus in producing the impression that the objects are both near and distant, although all the figures in his picture are equidistant from our eyes. Pictures, in which these laws of perspective have been neglected, for instance, old pictures of Van Eyk, Kranach, &c., appear flat. Hence arises the importance of a knowledge of perspective both to the painter and draughtsman.

The second method of giving a plastic appearance to flat objects is the proper distribution of light and shade.

We draw two right-angled triangles alongside each other, and both will appear as flat figures. As soon, however, as we shade the one with India ink, so that the shadow will gently decrease from the side towards the centre, the triangle, although always remaining a plane, will appear like a cone, and on the other hand round objects will often appear flat when these contrasts of light and shade are wanting.

The principal method of making plastic pictures is, therefore, by the proper employment of contrasts, and the artist has them in his power, but he must know how to use them. We will now proceed to the special consideration of these contrasts.

Let us consider first the raw material with which we paint,—the light. This ink, in its original purity, is so powerful that we cannot work with it in our studios when we wish to produce real half-tones.

In direct sunlight we will get a portrait glaring white on one side, and sharply defined, not gently shaded, and black on the other.

Even when the sunlight does not strike the model directly, the reflections from windows and other objects would become a source of great annoyance. Even curtains afford only a partial protection against this direct sunlight. A considerable portion of it penetrates, destroys the shadows, and makes the picture weak. For this purpose we not only exclude the direct sunlight from the model, but also from the atelier itself, by making the latter face towards the north. We go further and construct sunshades, working only with the diffused light of the clear or clouded sky.

While, generally speaking, the rays of sunlight may be considered as being parallel, those which emanate from the sky take all possible directions; horizontal when they come from the horizon, vertical when they come from the zenith. These circumstances are important. While in consequence of the parallelism of the sun's rays, a body on which the sun shines will show sharply defined contrasts of light and shade, a body illuminated by diffused light will show these contrasts obliterated. This is the reason why, under such circumstances, full and round bodies appear flat, as can easily be observed by looking at an intricate building on a dull day. It is no wonder that photographs taken on such a day always have a flat appearance.

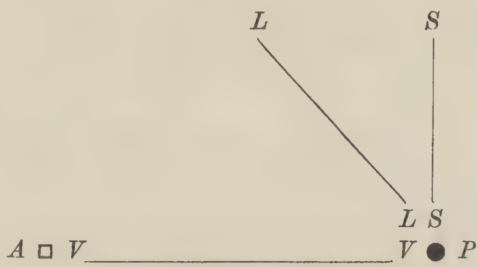
The portrait of a person would have an equally flat appearance if it received light from *all* sides of the atelier. This shows the necessity of employing a *one-sided* light when we wish to produce plastic pictures.

To make such pictures we supply our glass-houses with curtains, which we can raise or lower at pleasure. Such a *one-sided* light gives a living variation of light and shade. It does not follow, however, by any means, that the shaded side of a picture should not receive any light at all. On the contrary, it must be slightly illuminated, so that by chemical action too strong contrasts may

be modified, that the details may become visible, and that there may be a gentle transition from light to shadow. In which direction then must the principal mass of light strike the person?

Different cases are possible. The light may strike the person from the front, *i.e.*, coming from the direction towards which the point of the nose is directed; or sideways, *i.e.*, horizontally at right angles to the previous direction, and finally from above or in the direction of the longest axis of the body. We have to discriminate, therefore, between front-light, top-light, and side-light. Let us suppose now that the glazed side of the atelier is hung with curtains, and that a small slit is opened at the side of the person. If the person itself stands with its front at right angles to the glazed side, it is evident that it will be struck by the side-light. Turning now the chest and the head towards this light, it will be changed on the person to front-light. This shows that the direction of the light required depends on the position of the person, and it becomes necessary to define the expressions top-light, side-light, and front-light, in order not to be misunderstood; and as I shall in future frequently use these terms I will give the following explanation:

Fig. 75.



Suppose the paper be the floor of the atelier, and the square A the photographic apparatus, P the person. The direction of the head and chest is a matter of indifference. We call the light which strikes the person in the direction of the line V V (the connecting line with the apparatus) *Front-light;* the light which is horizontal at right angles to this, in the direction of S S, we call side-light; the vertical light from above the top-light.

Besides these three principal directions the light can strike the person in other directions, for instance obliquely in the direction of the line L L, as front side-light, or obliquely from above, as front top-light, &c., expressions which are easily understood. It is now my object to describe the effect of these three principal direc-

tions of light,—Front-light, Side-light, and Top-light. I give three photographs, one of which has been taken with front-light only, the other with direct side-light, and the last with top-light. With

Fig. 76.

O *S* *V*

O *S* *V*

the aid of these pictures we will see what a powerful effect the direction of the light has on the *relief*, the color of the picture, the *resemblance of the features*, and the *whole character* of the physiognomy.

V was taken with front-light: the size of the opening opposite the sitter was 7 square feet; the distance from the model 15 feet.*

S was taken with side-light: size of opening 5 square feet; distance from the object 8 feet.

O was taken with top-light: size of opening 3 feet 8 inches wide, and 5 feet long; the distance from the head of the object was 6 feet.

I consider it necessary to remark that the three pictures are portraits of the same individual, that they were taken immediately one after the other, and excepting the light, under circumstances as nearly identical as possible. I make this remark because the surprising difference which these three pictures exhibit—only in consequence of the different illumination—has caused many who have seen them to express doubts that they really were pictures of the same person.

The pictures were taken with a "Postage-stamp apparatus" for twelve heads, an apparatus which is very convenient for the production of quantities of pictures of this kind, and which is similar to the American Optical Company's Gem Camera.

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* The person was placed on the southern side of the atelier, the face turned towards the northern glazed side, at which the apparatus was placed.

Now let us first consider the effect of the different lights on the relief of the face.

We notice in *O* that the eyes are deeply sunk in their sockets, the nose is sharp and projecting, and casts a deep shadow; the fleshy parts below the cheek bones recede downwards, the mouth is large and sharply cut, while the beard projects thick and bushy.

In *S* the beard appears thinner, the parts under the cheek bones are much more flat, the roundness of the cheeks is wanting, the eyes do not appear so sunken. On the other hand we notice wrinkles above the nose, on the forehead and also below it, which in *O* are almost entirely obliterated. In *S* the wrinkles under the eyes and at the sides of the nose are less clearly defined than in *O*. The whole face in *S* has, owing to the rather sharply defined limits of the shadows, the appearance of a box illuminated from one side, and the edge of which is turned towards the eye; the whole middle line of the face projects much more than in *O*. The face is goat-like.

V is like a box seen from the flat side; the sockets of the eyes are scarcely indicated. Of the characteristic lines, which in *O* and *S* start from above, below, and at the side of the nose, not a trace is left. The beard and the clothing appear as flat as the face. The nose is gently lost in the eyebrows, and forms with these two symmetrical hooks. The mouth appears *small* when compared with *O*. The whole is like a board on which the main outlines have been drawn. *This shows that with the aid of illumination we can obliterate wrinkles and cavities in the face, or can make them appear more prominent.*

When we consider the effect of the illumination on the color of the different parts, we will notice at once the great difference in the color of the hair and the beard. They appear strikingly gray in the photographs *O* and *S*, where the light falls on them (the most so in *O*), while in *V* the color is black.

In *O* we recognize each individual hair, and also on the light side of *S*, while in *V* the hair and beard form a homogeneous black spot, with very little detail.

The cause of this want of detail is the equal illumination which every hair receives from the front, so that we can only see the light side. It is quite different with side-light, where we see on every hair its bright and its shaded side, and thus each hair becomes distinct from the other. The hair in *V* appears much darker. The reason of this is that the model was much further removed from the light when the picture was taken. This is also the reason why

the coat appears much darker, and why the background in *V* appears much lighter than in *S* and *O*, simply because it received as much light as the sitter (except where the background is shaded by the person), while in *O* and *S* the background stands a few feet back of the light opening, and receives only that part of the light which either vertically or horizontally strikes the person.

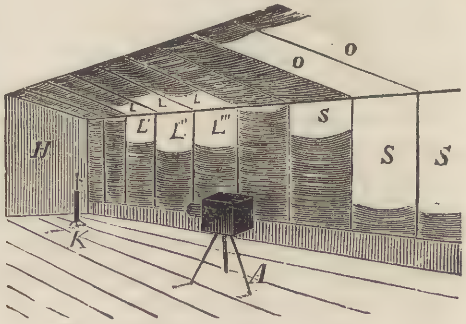
The bright color of the coat in *O* (the coat of the sitter was black) must be noticed. The top-light acts with the greatest chemical intensity; hair and forehead are unusually bright with this light, while the shadows are very deep. *This demonstrates that with the aid of illumination we can modify to a considerable degree the color of hair, background, and clothing.*

The next point to be considered is the effect of illumination on the character of the picture; and the most superficial observer must admit that a great many, who believe that a clean and neatly executed picture must always be a good likeness, are grossly in error.

The eyes in *O* look dark and threatening, and this sinister expression is increased by the sharp projecting nose, the dark-colored compressed corners of the mouth, the prominent cheek bones and nostrils, which throw deep shadows. How harmless and even sleepy the picture in *V* appears. The shadeless eyes look fishlike and expressionless, the lines which give energy to the face are wanting, and the mouth is without expression.

FIG. 77.

FIG 78.



The picture *S* is intermediate between the two. It is not so insipid as *V*, nor so sinister as *O*. The contrasts of light and shade give a lively expression to the face, in which the two wrinkles on the forehead look as if they were produced by a cunning thought; only the shaded side appears still a little too threatening when compared with the light side. The picture is more characteristic

than the other two, but it does not show us the man as he is; it is too angular, and he looks too much like a goat. *We see from the above how the whole character of a face may be varied considerably by illumination.* We can make a gruff and unhappy-looking face appear to look cheerful and pleasant, and we can give an energetic expression to a sleepy-looking countenance.

But my readers will ask, Which of the three pictures shows the true character of the man? and I answer, None of them. That every one may get an idea how the man actually does look, and form an idea how the three different modes of illumination have changed the expression of his countenance, I add the portrait which all his friends consider a perfect likeness, and a true representation of his character. (Fig. 77.)

What I have said above will, I think, be sufficient to impress the reader with the importance of illumination in photographic pictures.

Each of the three different modes of illumination—front-light, top-light, and side-light—gives a different character to the model.

It is the duty of the photographer to make pictures in which the true character is reproduced.

How may this be accomplished? The best results are secured by a combination of all the three different modes of illumination—*i. e.*, top-light, front-light, and side-light, or what is the same thing, a front top-light from an oblique direction. In this case the main quantity of light which strikes the person proceeds from an opening which is a few feet in front, above, and either to the right or left, in such a manner that the light strikes the sitter at an angle of about 45°.*

This method of illumination produces the rotundity and relief of the model in the richest manner, and painters make it the foundation of their shadow constructions.

We find this illumination also in most of the pictures of our prominent portrait painters, simply because it appears to our feelings as being the most natural, and there are many photographers who will, as if by instinct, place their model in exactly that corner of the atelier where this mode of illumination is produced by local

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* In an atelier which is hung with curtains as illustrated in Fig. 78, such an arrangement of the light is easily managed by removing some of the top curtains, *L*, *L*, and the adjoining side curtains, *L′*, *L″*, a few feet in front of the person, *K*. The other openings, *O*, *O*, *S*, *S*, are for lighting the shadows. See below.

causes. Others, again, have put up curtains and removed them again, have changed their glass-houses, until finally their pictures assumed that natural appearance which depends altogether on the illumination.

With such a light, and with the combination of the three different methods, the fourth head, in Fig. 77, is taken, and an attentive study of the same will soon demonstrate this to a careful observer.

When we consider the effect of such a normal light on the model, we will find that on the forehead (for instance, on the right), the strongest light, while on the opposite side, on the lower jaw, we will find the deepest shadows. There are a number of ateliers where this mode of illumination is employed with every model, without exception.

The model is placed in a spot from which the side and top-light is excluded by curtains and masonry; consequently he will receive light mainly from the front.

Such an arrangement may suffice for a great many faces, but it cannot be denied that by employing the same mode of illumination invariably, the pictures will become monotonous.

In photographs this monotony is even more objectionable than in oil paintings, as the painter by the aid of colors has the means to produce a great variety of effects. It is quite different with the photographer. In his hands light and shade have to replace the effects of color. He can replace variety only by a skilful manipulation of the illumination, and the more or less inclined angle under which the light strikes the object is here of primary importance.

We have to mention that a top-light, O, or a side-light, S (Fig. 78), proceeding from a great distance, produces a similar effect to that of a front-light. A top-light of large dimensions, immediately above the sitter, is in its effects similar to a side-light, a circumstance which must be borne in mind in an atelier which is wide, but comparatively low, and *vice versa.* A very high side-light will produce similar effects to a top-light, as can easily be noticed in any very high atelier.

It follows that as we increase or diminish the size of the opening, L, L, or as we approach it or remove the sitter from it, we can give to the light more or less the character of front-light, top-light, or side-light, and modify the character of the model to a considerable extent.

Suppose we have a well-marked, energetic, and expressive face. By removing the sitter from the source of light, we give the char-

acter of front-light to it, and infuse mildness and softness into the harsh features.

And so the other way, when we have a flat, sleepy, and otherwise little-marked face, we should give to the light more of the character of top-light, and the face will get more energy and life.

With certain small-cheeked faces, the employment of side-light is to be recommended. It lights up the cavities under the cheek bones on the light side, makes these concave parts appear more rounded and full, while the details on the other side are lost in shadow.

For ladies of a "certain age," who sometimes become very annoying to the photographer, the employment of a gentle front-light is to be recommended. It will light up the wrinkles and remove the unpleasant shadows.

Yes, we can place the whole face in the shadow (which of course must not be too dark), only throwing a few light-effects over the most prominent parts, and still get good effects.

Generally speaking, we may lay down the rule that we must illuminate all the elevations and depressions which we wish to modify, in such a manner that they throw no shadow, or only a very small one, and *vice versa.*

It is self-evident that we dare not go too far in this respect. We can modify the shortcomings of the original, but we must not obliterate them altogether, for in that case character and likeness would be lost. How far we may go in this respect cannot be determined by any rule, but the thinking artist must be guided by his sight and the gift of observation.

The observing artist will also notice a slight difference in the brightness of the hands and the face. *In every portrait the face is of paramount importance. It must receive the principal light, and all the other parts must be kept subdued* and subservient to it.

Nothing can be more repulsive than those pictures where the arms and hands appear as prominent white spots, strongly contrasting with the drapery and clothing. The upper part of the body should be kept lighter than the lower parts. *With dark screens, which are placed a few feet from the sitter, and partially shade the hands and feet*, this is easily accomplished. Loescher & Petsch use such a shade-screen with great advantage, particularly in avoiding over-exposure of white dresses. The screen is a frame five feet wide, covered with dark cloth, and moves on rollers. The upper part is movable around a horizontal axis, so as to give more

or less inclination. It is self-evident that the production of such light-effects requires a skilled eye, which will appreciate the slightest gradations from light to dark.

For training the eye in this respect, I would recommend the photographer to practice on plaster of Paris busts. Such a bust should be placed in the atelier on the same spot where the sitters are placed. All the light should be excluded by closing all the curtains, and now, by admitting the light first from one direction, then from another, now from above, and next sideways, the effect on the face should be carefully watched.

The variations are not only surprising, but entertaining and instructive, and whoever will take the trouble to photograph them, and make a short memorandum of the mode of illumination, can make for himself an album of studies that will materially assist him in selecting the proper mode of illumination for the living model. But he must not forget that one effect is not suitable for all, and the illumination should be adapted to the sex, age, and physiognomical peculiarities of the sitter.*

All that I have shown as taking place on the human face repeats itself on all other forms. Just as cavities or prominences on the human head can be obliterated or exaggerated by the mode of illumination, so also can we modify the appearance of other plastic objects, as buildings, bas-reliefs, machinery, &c.

It is the rule to illuminate in such a way that the details which we desire to show prominently in the picture are by the illumination brought to the proper prominence. Art objects make the choice of illumination easy, in so far as all artists place their models under a light which strikes the object at an angle of 45° obliquely from above. Whether the obliquity is from the right or the left side is still a question, and when the artist himself does not give the direction, experiment must show from which side the light acts the most favorably. Without subjecting oneself to examination and criticism, we will never obtain a satisfactory result.

This oblique light with an inclination of 45 degrees will, under most circumstances, be the most suitable.

Two more points have to be considered,—the size of the object and the distance of the source of light, *i. e.*, the window of the atelier. Suppose we have two pillars, one of large diameter, *a*, and

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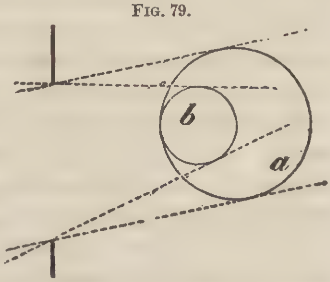
* About certain light-effects, such as the popular "Rembrandt" effects, I will speak further on in the chapter on Backgrounds.

a small one, b, placed at equal distance from a window. It will be easily seen that the first will show a different illumination from the second. The light plays more around the smaller pillar on the shady side than on the large one. The shady side contracts while the light side expands. If we wish to photograph the smaller pillar, under similar conditions of light and shade, we have to decrease the light *opening.* This is the reason why an illumination which has been arranged for a life-size model is unsuited for a smaller object.

Fig. 79.



The second point is the distance from the glass wall.

We have shown above that the brilliancy of a point, which receives the light of the sky through a window, decreases as the square of the distance from the window increases. With a very large window opening this decrease is not so strong, but still very perceptible (see page 27) when we consider that the shady side of a model is only illuminated by the light reflected from the back wall of the atelier. It becomes evident that the contrast between light and shade will be stronger as we approach the model to the glass wall; we have it in our power, therefore, to increase or decrease these contrasts by placing the model in different positions.

It must not be overlooked that, generally speaking, contrasts are stronger in photographic pictures than they appear to our eyes. Very often the shaded side, which to our eye represents all the details, appears on the photograph as a pitch-black spot. This is most striking with yellow, green or red objects, less so with white ones, or cobalt and ultramarine blue.

A plaster bust will generally, even without artificial arrangements, show good details in the shadows, but it is different with human beings, and still worse with dark-colored objects, such as iron and bronze. When it is intended that the shadows of such objects shall not appear altogether black, we must either introduce direct light on the shadow side or arrange reflectors to throw the light in that direction.

In an atelier with a north front the illumination of the shadows by direct light is an easy matter. Generally the model is placed near the glazed wall, in the place where in Fig. 15, the white pillar has been placed. By opening the curtains, L' L'' L''' (Fig. 78), to the right, we get an illumination that would be suitable for the painter.

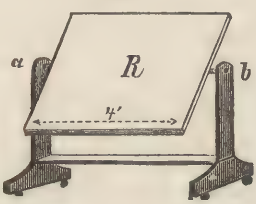
In order to illuminate the shadows properly we open on the other side of the atelier part of the top-light curtains, *O O*, and side curtains, *S S*, Fig. 78. A quantity of top front-light pours in upon the model, which by itself would produce a picture like *V*, page 242, but combined with suitable side-light produces the result on page 244.

To the eye the effect is visible on the model. By increasing the amount of front-light the time of exposure becomes relatively shortened. The light and shade contrasts become more and more decided by approaching the model to the glass side of the house.

The illumination by reflecting screens is very generally employed. When the atelier is small and the rear wall light, the latter will act as a reflector, and many photographers will only notice this fact when they are suddenly placed in another larger atelier with a dark rear wall. The floor of the atelier acts similarly to a reflector. It lights the lower shadows of the model. This effect is also very often overlooked. Every object in the atelier, provided it is not absolutely black, acts more or less as a reflecting screen. Those photographers who boast that they work without reflecting screens may make a note of this.

For a movable reflecting screen I would recommend a frame, *R*, which revolves around the horizontal axis, *a b*, and is moved from place to place on rollers. Others are so arranged that they can be placed high or low. One side of the frame should be covered with tin foil, the other with white paper. This secures two surfaces of different reflecting power.

Fig. 80.



The frame is placed on the dark side of the model, and moved in different directions until the eye observes that the shadows become lighter.

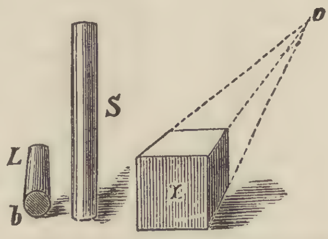
To the beginner I would recommend experiments with a plaster bust. The effectiveness of the screen increases the nearer we place it to the model. As regards the most suitable position of the reflecting surface we soon notice that, even with a dull surface, such as paper, the action is analogous to a mirror, *i.e.*, the angle of incidence is like the angle of reflection.

Besides such reflecting screens the thinking artist can employ many other accessories for the same purpose; a sheet of white paper, an open book placed upon the table, a hidden mirror, and other trifles, will often produce very favorable effects.

OF THE PERSPECTIVE.

When we look at a cube (Fig. 81), the sides of which being of equal length, we will find that they *appear* to our eye of very different length. The surface fronting our eye appears as a square; the others become shortened in a remarkable manner. The surfaces appear quite irregular; the parallel lines converge towards the point *o*. Similar appearances we notice on all other bodies. The human arm hanging down along the side of the body, or the pillar, *S*, standing upright, appear of *full* length, while the arm stretched towards us, or a pillar lying in a horizontal position, *L*, appear "foreshortened." The parts appear contracted, and finally we see, instead of the shaft of the pillar, only the circular base, *b*, which either appears circular when we face it directly, or as an ellipse (which it is not in fact), and the parallel sides of the pillar converge to a point. The reason why we do not notice this falsehood (for such it is) is simply because we are used to it.

FIG. 81.

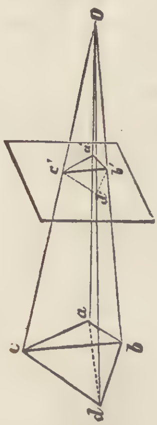


We know from experience that the arm pointing towards us only *appears* short, and that it is longer than it appears to us. We know also that the apparently converging railroad tracks run actually parallel. We constantly correct, by our experience, the appearances of our vision. A child without experience will try to seize the moon. It is the duty of the painter and the photographer to represent the foreshortening correctly, *i. e.*, as they appear to *our* eyes; and when this is not done the picture will be untrue.

The perspective teaches us the laws of foreshortening. Our eye is a camera obscura with a simple landscape lens. We know from optics that the image of a point lies on the straight ray which is drawn from the point through the centre of the objective. Where this line, which is called the principal ray, cuts the plane of the picture (the ground-glass in the camera or the retina in the eye), we will find the picture of the point in question. The image of a straight line is where the rays which proceed from the different points of the line, after passing through the centre of the lens, intersect the ground-glass. These lines form a plane in the optical centre. This plane cuts the plane of the ground-glass in a straight line. The

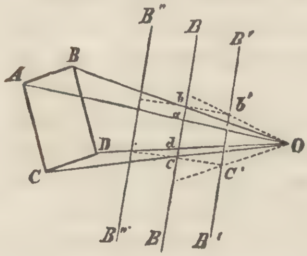
image of a straight line is, therefore, in our eye a straight line, and the image of a plane triangle is a plane triangle. When the plane figure on the retina, or the ground-glass, is parallel to the object, then, according to well-known stereometrical laws, the image will appear similar to the original figure. Suppose that a plate of glass has been placed in front of the eye vertical to its axis. Then the rays which proceed from an object, *a b c d*, will intersect the plate in the figure *a′ b′ c′ d′* (Fig. 82). When we construct such a figure for a given point of intersection and a given plane, then the drawing, when it is brought to the correct position and distance in front of the eye, will give exactly such an image as the objects themselves. This explains the deception that a correctly constructed plane picture appears in relief. A picture drawn in the above-described manner we call a perspective drawing. It is self-evident that we must look at it under the same conditions under which it was drawn.

FIG. 82.



Suppose that *A B C D*, Fig. 83, is the ground plan of a house, *B* the ground-glass, *O* the focus of the rays, *a b c d* the image of *A B C D*; then it is necessary that I should place my eye at *O* in order to see the perspective picture, *a b c d*, exactly as the object itself.

FIG. 83.

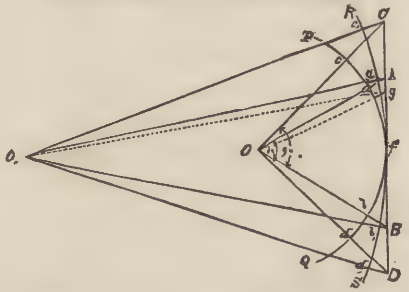


When I move the ground-glass closer to the eye, for instance to *B′*, it is easy to see that the rays must cross each other in the eye under an entirely different angle from those which proceed from *A B C D*; and they cannot produce a correct impression. The same would take place if I should remove the picture-plate away from the eye (for instance to *B″*). Hence it follows that every perspective drawing should be looked at from the standpoint from which it was taken in order to produce a correct impression.

Photography is a perspective drawing where the point of sight lies in the object-lens; and hence the eye must be placed at the same distance as the object-glass (*i. e.*, its focus). When this is not done the impression is untrue.

There are, however, lenses of four inches focus and less; at so short a distance it is impossible for the naked eye to see a drawing, or anything else. Generally we look at them at a distance of at least eight inches, and the consequence is that the photograph

FIG. 84.



produces an unnatural impression. This is very often the case with pictures taken with wide-angle lenses.

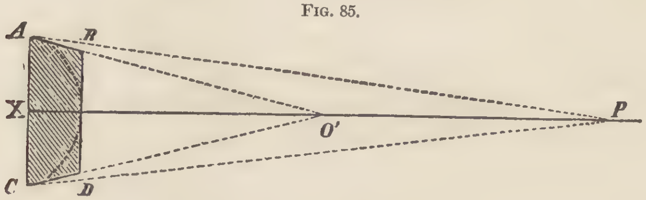
When we look at these from too great a distance, $O' f$, we will notice the too great expansion of the marginal parts. The foreground and the sides appear disproportionately large. When they are placed at the correct distance, $O f$, which is equal to the focus of the lens, then the angle of vision, $C\ A\ O$, of the too wide marginal parts, $A\ C$, $B\ D$, will shrink considerably, as they will be seen considerably foreshortened (see above), and the picture will make a correct impression.

These errors do not show themselves in so striking a manner with pictures that have been taken with lenses of a smaller field of vision. When, for instance, the angle is equal to 60°, it does not make much difference whether we look at the picture from the single or double focal length, as a glance at the small marginal piece, $A\ g$, of a field of vision of 60°, will demonstrate. This is the reason why we do not notice the false perspective, so common in portraits which have been taken with lenses of a short focus, as the field of vision of these lenses is less than 60°. But other abnormities will manifest themselves which we must not overlook.

When we take from the point P (Fig. 85), the picture of a pillar, the ground section of which is, $A\ B\ C\ D$, the lens to have a focus of seven inches, we obtain a picture in which the sides $A\ B$ and $C\ D$ are visible. When we substitute, however, a lens of three and a half inches focus we would have to approach the object in order

to obtain a picture of the same size as with the 7 inch lens. For instance, from the point O', the sides A B and C D are no longer visible; the whole character of the picture becomes changed. When we substitute a human face for the pillar it is evident that, with the lens near to the object, the cheeks will contract and appear too narrow in proportion to the length of the face.

FIG. 85.

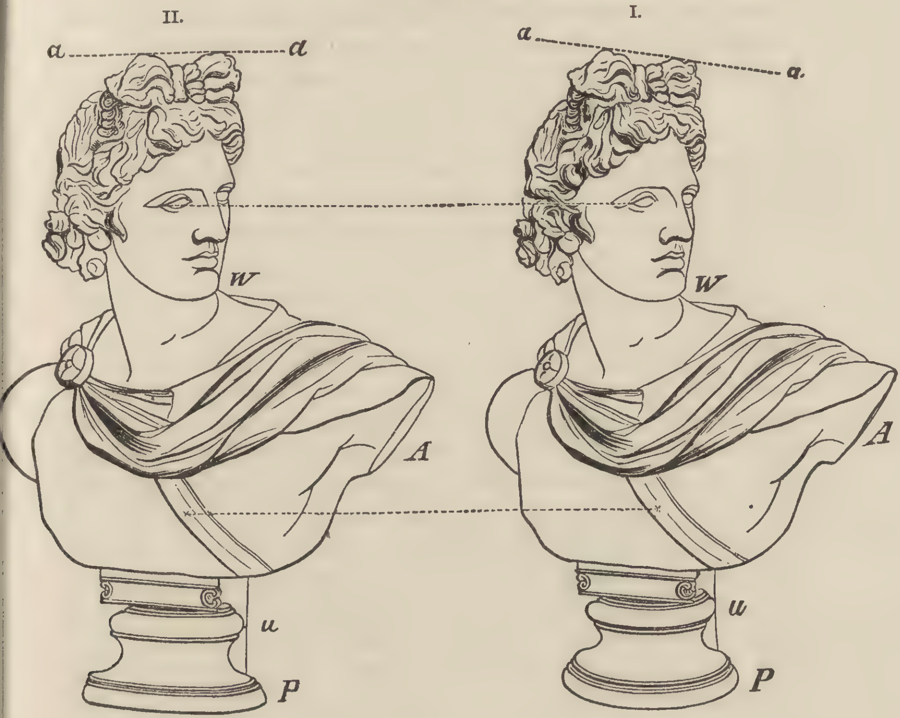


The correctness of this conclusion the following two illustrations will demonstrate. They represent two pictures of the bust of Apollo. The bust was placed exactly vertical, the camera likewise, and the direction of the line of vision carefully adjusted. The picture, No. I, was taken with a small patent Dallmeyer lens, at a distance of 47 inches; the picture, No. II, was taken with a Steinheil Aplanatic lens, at a distance of 112 inches.

The difference is striking. In No. I the figure appears slender, the chest is almost feeble, while the same model yields in No. II a full-faced, robust figure. That this slenderness does not depend on an illusion a measurement of distances will best illustrate. The distances between the eye and the point marked on the chest with a cross are exactly alike. The greatest expansion of the chest, however, including the stumps of the arms, amounts in No. I to 56 millimetres, and in No. II to 59 millimetres. Looking aside from this dissimilarity, the character of the two faces will reveal to the attentive observer other striking differences. A line, *a*, *a*, applied to the hair of the figure will run horizontal in No. II, while in No. I it inclines to the left of the figure. The pedestal, *P*, differs likewise. In I, the rings are strongly inclined ellipses, while in II they are quite flat. The stump of the arm, *A*, *A*, shows hardly any surface in I, while in II it becomes quite prominent. The support of the back extends in No. II, at *u*, further to the right. The head is in II more between the shoulders (see the angle of the neck at *W*), and the whole figure seems to elevate the head more in No. I than in No. II. In II the head seems almost to incline forward, and yet the figure was immovable, the lenses were free from dis-

tortion, the direction and height was in both identical; nothing was different but the distance.

Fig. 86.



Besides the two pictures above described, two others were made under exactly similar circumstances at a distance of sixty and eighty inches, and when we place the four heads alongside of each other, we notice that with increasing distance the figures appear stouter and more robust, the head line inclines more and more, the ellipses of the pedestal become flatter, the chest increases in breadth, and the stumps of the arms become more prominent. These differences will show themselves when we take the same head with the *same lens* and only change the distance from the object.

The author took the Apollo head with a Dallmeyer stereoscope lens at distances of five and ten feet. The latter picture is of course only half the size of the former. Differences were not visible to the naked eye on account of the smallness of the pictures, but they became quite evident by magnifying them, and showed the same differences as shown above in the illustrations.

We thus see how *different distances yield different pictures* of the same object, exactly as a different direction of the light will give a different character to a portrait of the same person.

Some will say that all this is trifling, and that it does not make mnch difference whether the Apollo is a little stouter or a little more slender. So far as the Apollo is concerned this may be a matter of indifference (most people do not know how the Apollo looks at all); but the case is quite different in portrait photography, and where the customer's own dear self is concerned. For their own physiognomy even inartistic people have an exceedingly keen eye. The most trifling things—a line, a wrinkle, a curl—is criticized, and differences, which are not noticed in the Apollo, are easily observed in the counterfeit presentment of themselves.

It is the duty of the photographer to pay attention to distance.

To the photographer who only works mechanically this may be an inconvenience; but the intelligent and ambitious artist will know how to take advantage of it. He will not make a thin person appear still thinner by taking a photograph at a short distance, nor will he increase the circumference of a stout one by placing a considerable distance between the camera and the model. This is particularly the case with bust pictures, but still more so with large heads, where on the one hand the distances are short, and where on the other hand the breadth of the body is almost equal to the height of the figure (so far as the same is visible in the picture).

With standing figures, where the breadth is comparatively small in proportion to the length, these errors caused by distance are not so apparent.

Perhaps many will wish to know which distance is the proper one, and which gives the most correct picture.

This depends upon the individual, I might say, and refer to the example of the stout and slender person, which I gave above, and where entirely different distances are proper. Generally speaking, painters recommend, for making a drawing, a distance which is at least twice as great as the height of the object. For a person five feet high, the distance would be ten feet; for a bust (half the length of the body), a distance of about five feet.

The painter, however, has greater freedom. He can add, or leave off, or change, just as he chooses. His guide is his artistic feeling. I think that the photographer needs this feeling also. The opticians have furnished him with different lenses, that he may make pictures of the same object and of the same size from different

distances. A portrait photographer should be provided with lenses of different focal length.*

Everything is proper *when employed in the right place.* And thus the question is answered: Which portrait apparatus furnishes the most correct picture, particularly when the negative has to serve for enlargement.

The preceding chapter will demonstrate that even a correct drawing lens will give different pictures at different distances. I obtain a different result when I take a picture at five or ten feet distance. With small sized pictures, these differences are not very striking; but when we enlarge to life size, they become very noticeable, and every one will observe them.

Let us suppose that the original is five feet high, then it will require, according to the above academical rule, a distance of ten feet to give a proper standpoint for the contemplation of the same. But in order that the picture should make a correct impression at this distance, it is necessary that the negative be taken at the same distance, no matter with what objective, provided it draws correctly and defines sharply. If it has been taken at a shorter distance, the life-size picture will appear, under the given propositions, untrue.

These circumstances are modified by the nature of the object.

Let us take as an object an artistically sculptured chalice. In drinking out of it or in looking at it we take it in our hands and place it at a distance of about two feet from our eyes. We will get a true picture of such an object only by making a photograph at such a short distance, and the truth of this assertion becomes quite evident when we magnify a picture which has been taken at a greater distance. The untruth of the latter becomes evident at once by comparing the picture with the original, particularly when the width of the latter is large in comparison to its height.

Cavities are different from prominences.

When A B, C D (Fig. 87), is the interior of a box, we will see the side A B from P much more foreshortened than from O' or N. If, therefore, a picture is taken under like circumstances from near or far, it will appear in the former case broader in proportion to

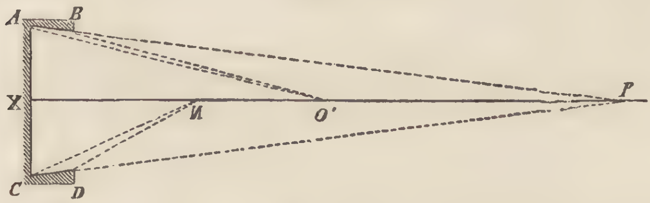
* For large heads of carte de visite size, which are now in so much demand, he should have three numbers of sufficient light (a point of great importance) at his command:

1 portrait head of about 24 lines and 4 inches focus at about 5 feet distance.
1 " " 30 " 7 " " 7 "
1 " " 36 " 12 " " 11 "

In most cases the second one will be sufficient.

the height. This relation becomes evident in taking a perspective street view. At a short distance, with a wide-angled instrument, the nearer parts will appear unusually broad. The same will happen when we suppose that A C represents the body and C D the lap or

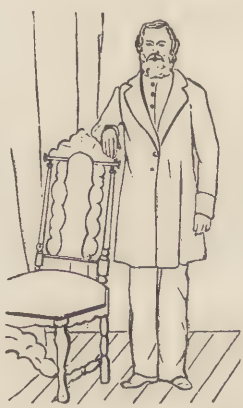
FIG. 87.



the feet of a sitting person. The lap will appear much broader in proportion to the body. It would be the same if C D represented the feet of a person facing the camera. They would appear larger from N. Finally, let us imagine that C D represents the carpet or the floor of a room; it would appear broader or with a steeper ascent from N. When we take a picture of one and the same person from two different standpoints, P and N, with two lenses of different focal lengths, in such a manner that the height of the body shall remain the same in both pictures, we will find in the pictures taken at a short distance that the projecting parts (hands, feet, lap, &c.) are too wide, while the receding ones, as the cheeks, are too small; the floor and chair ascend too much (Fig. 88). For comparison, look at the picture, Fig. 89, which has been taken from a greater distance. When we suppose that A B (Fig. 87) is the

FIG. 88.

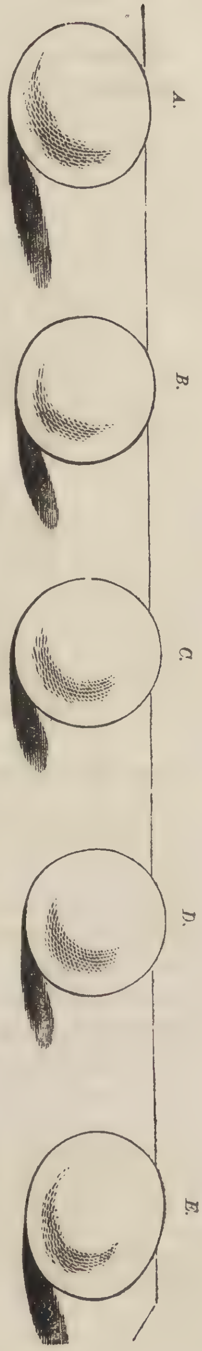
FIG. 89.



ground-plan of a house or a window, then it will appear broader when taken from O' than if taken from P.

This is the reason why windows and doors appear too broad when taken at a short distance with a lens of a wide field of view, and hence look compressed, as will be noticed in many pictures taken with a pantoscope apparatus. This is also the reason why the distance of the apparatus and the size of the field of vision are of so much importance in giving a true picture of an object. How, under these circumstances, and even with a perfectly correct perspective, quite abnormal figures are produced, the annexed picture of balls will demonstrate. Balls will always appear round to us, or circular; but when they are located at the margin of the field of vision—*i. e.*, when the rays intersect the plane of the picture under a very oblique angle, then the perspective figure, even when mathematically correct, will be an ellipse. (See page 233.)

Fig. 90.



Such a figure we will not consider a true one, as our eye has been accustomed to seeing a ball under any circumstances as a circle, and we cannot blame the painter when he ignores the rules of perspective and draws them always as circles. Unfortunately the photographer cannot do the same; he must reproduce the figure which the lens, constructed according to mathematical principles, furnishes.

Distortions similar to those described on the balls will always manifest themselves with lenses of comparatively small fields of vision. The balls *B* and *D* are on the margin of a field of only about 35°. The balls *A* and *E* are at the edge of a field of $64\frac{1}{2}$°. The former angle is nothing unusual with portraits, particularly with groups. The latter is frequently employed in landscape and architectural photography. The marginal figures will easily appear too thick when taken at a short distance with a wide field of view. Look at the two figures (Fig. 91, Fig. 92); they are the marginal figures of the same bas-relief; the one taken at a distance of $3\frac{3}{4}$ feet, the other at $8\frac{3}{4}$ feet. The head in Fig. 92 appears twisted, thick, and the left foot turned outwards, while Fig. 91 is more correct.

In taking groups a long distance should be chosen, and stout persons should not be placed at the margin, but in the centre, and we should only employ a large field of vision when circumstances admit of no other.

Still another point is the height of the apparatus and its direction.

The normal position of the apparatus is the horizontal one. In that position the eye-point—*i. e.*, the point where the continuation

FIG. 91.

FIG. 92.

of the axis of vision would intersect the plane of the picture—would fall in a line exactly in the horizon—*i. e.*, in the line where, on a large sheet of water, the water and the sky appear to meet.

This normal position, however, is maintained by photographers only in taking architectural views. When it is neglected, in such cases the vertical lines of the buildings will not appear vertical, but inclined—*i. e.*, converging at the top when the apparatus is turned upwards, and converging at the bottom when the apparatus is turned downwards.*

Such pictures look very ugly. With portraits and simple land-

* The explanation is easy. The rays proceeding from a straight line will form a plane at the point of crossing, and this will intersect the plane of the ground-glass in a straight line. When we imagine a succession of lines parallel to the ground-glass, the planes of rays proceeding from them will intersect the ground-glass in parallel lines according to well-known stereometrical laws. When, however, the ground-glass is inclined, the intersecting lines will converge.

scapes we very often deviate from this horizontal position. The eye-point must be looked for either in the ground or in the sky. In this case we will see in the former instance more of the ground, and in the latter more of the sky. Under some circumstances this may be an advantage. In rows of trees, where we wish to avoid an excessive foreground in order to get an insight into the splendid mass of foliage, we must direct the apparatus upwards.

Bedford has done this. That the stems of the trees converged did not matter much. What influence the inclination of the apparatus exerts in portrait photography is shown most strikingly by taking the picture of a bust with an apparatus pointing upwards, and then from the same standpoint with the camera pointing downwards, as the annexed figure (93) shows. In the first figure the head appears to incline forward, like that of an old man; in the second the person stands perpendicular, like a soldier; while in the third instance the head is thrown backwards and the eyes are turned heavenward.

The effect becomes still more striking with antique statues. Generally they are calculated and executed for a high standpoint. They must be copied with a camera turned upwards, while with reclining figures (Endymion, Cleopatra, or Queen Louisa) the apparatus should be turned downwards.

The elevation of the apparatus above ground is of still more importance. Many mistakes are made in this respect. The normal height is the height of the eyes above ground, which for a standing figure is about four and three-quarters feet. When the apparatus is placed higher,. we will see the objects from above (bird's eye view); when we go lower, we will see the objects in what is called a frog perspective. For a sitting figure, we may assume the observer to be in a sitting posture—*i. e.*, the eye or the camera at a height of about four feet. For a sitting person the apparatus is generally placed on a level with the head of the model and inclined forward, while for a standing person the height of the chest and the horizontal position is adopted. In the former case we can elevate the head of the model; in the second case we can depress it to equalize errors.

When the apparatus is placed too high the person will appear more in a bird's eye perspective, and we see a larger part of the top of the head. The eyes appear depressed, the throat is covered by the chin, &c. When the apparatus is placed too low the reverse takes place. We look into the nostrils and the sockets of the eyes; we look under the chin, and the forehead becomes foreshortened.

FIG. 93.

In landscape photography the height of the apparatus is still more important. In order to gain a proper standpoint we have to ascend buildings and climb mountains.

We must observe that all the parallel horizontal lines which are not parallel to the ground-glass will converge towards a point in the horizon—the point of *disappearance* or vanishing point.

As the horizon is located in the height of the eye—*i. e.*, the camera—it follows that the ground will ascend more and more as

FIG. 94.

we raise the horizon. See Fig. 95, where the eye-point is taken at the normal height of a human figure, the next at the height of the hips (Fig. 94), and the third at twice the height of a human figure (Fig. 96). In the first picture, where the horizon is lowest,

FIG. 95.

the lines of the street ascend gently; the upper parts of the window, however, form strongly inclined, or, as they are called, *tumbling* lines; the lines of the step incline, and the milestone reaches to

the clouds. When we ascend the steps (Fig. 96), the ground lines ascend more, and the window lines are more horizontal. From such a standpoint the lower objects appear in a bird's eye perspective; persons and trees become foreshortened and appear small

FIG. 96.

and compressed; it does not create a natural impression to see the ground ascend over objects which we are used to seeing prominently above ground, or to see the lines of window sills, which generally run in a descending direction, become ascending. Such a high standpoint in taking a street view is only to be recommended when it offers other great advantages.

Here is still another point. In a perspective view, the lines of the cornices of a building will appear to *tumble* when viewed from a normal standpoint—*i. e.*, the height of the eye of a standing person; more and more so the higher the building is. We are accustomed to calculate the height of a building from the degree of inclination of the upper lines. This is the reason why buildings taken from a high standpoint, where these lines approach to the horizontal, appear low and depressed, and fail to make a great impression.

Paul Veronese, who painted a splendid hall, knew this effect very well. He gave to the upper lines a strong inclination, and placed the eye-point intentionally lower for them than for the floor, in order to make them steeper.

He has offended the learned mathematicians, but gained in artistic effect. It is not intended that a picture should solve a mathematical problem or conform to it.

In narrow streets the selection of the proper standpoint is often so difficult that in spite of all our good intentions we must be satisfied with something very imperfect.*

ARRANGEMENT.

We very often hear in ordinary life the commonplace remark, "artistic confusion," and many draw the conclusion that every chaotic mixture of objects must be artistic. We will not investigate here how many photographers hold this view. I have known one who in order to heighten the effect of his landscape dragged all possible things into it. Piles of wood were carted to the place, stones were thrown in the foreground, the wheelbarrow on which the apparatus had been moved had to do duty, and when nothing else was to be had, the ground in front was dug up in order to make the view "*picturesque.*" He did still worse with his portraits; clocks, picture frames, vases, chairs, bottles, and foot-stools were so piled together, that finally it became difficult to find the person amongst the heap of rubbish.

It requires an advanced artistic education to understand that disorder and picturesque are ideas by no means identical. It is not artistic when the objects in the picture are arranged with a stiff symmetry and mathematical precision; as, for instance, the sacred pictures of the oldest schools of painting; in the centre, we find the holy virgin, to the right and left each six apostles drawn up like soldiers of the line, and not only symmetrical in position, but also in the carriage of the hands, feet, and head; the left side of the picture the exact counterpart of the right. Art demands liberty and order, and this shows itself in an *easy symmetrical arrangement.* Man himself is a symmetrical figure; we can divide him into two parts, and the one part would be the exact copy of

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* I have seen views of the staircase in the Museum in Berlin which were taken with wide-angled lenses. In these the joists of the ceiling are taken from below (frog perspective), while the statues on the groundfloor are taken from a bird's eye view; however, the public is satisfied; all they want is to have a picture with a great many objects in it; how they look does not matter. From this desire to see a great deal at once originated probably the mania for ascending mountains. Every one is delighted with the view from the Brocken (Harz Mountains), although it is bare of all beauty; but we see a great deal at once, although very little that is beautiful.

the other; for example, a soldier making "front face," the legs together, the hands drawn close to the body, the head directed *vertically forward.*

A person will *only take such a position* when forced to do so, and it will lack beauty because it is unnatural. Let us contemplate a man standing in an easy position (Fig. 97); he will very seldom

Fig. 97.

rest on both legs, like a soldier, but generally rests on one, the *supporting leg*, while the other is left free. Neither do both arms hang down, but he places them in different positions, and generally the head and body are turned in different directions; and hence it

is that he appears, even in the lifeless picture itself, capable of motion, while the symmetrical soldier appears even in life stiff and rigid, and still more so in the picture.

As an example of an easy symmetrical arrangement, the annexed sitting figure (Fig. 98) may serve as an illustration.

To the left seam of the coat the right one conforms (almost too symmetrical), the left collar of the overcoat corresponds with the

FIG. 98.

right one, although in a different arrangement of the folds. The line which ascends from the left arm corresponds with the one which ascends on the right from the other. Both culminate in the head, which, however, like the feet, is independent of the symmetrical arrangement.

I have just called attention to the symmetry of lines. A line, *a*, descending to the left, corresponds with a line, *b*, descending to

FIG. 99.

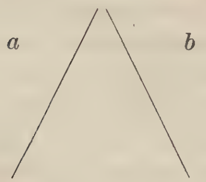
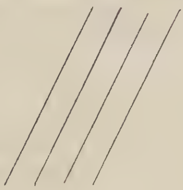


FIG. 100.



the right (Fig. 99); such lines support each other, so to speak—they balance each other. When the picture consists altogether of

oblique parallel lines, this balance is not maintained (Fig. 100); and this want is felt at once by the observer, although he cannot explain to himself the reason. In the next picture (Fig. 101), for which, and three others, we are indebted to Mr. Robinson's excellent work "Pictorial Effect in Photography," a great many of the main lines run in the same direction. The legs of the figure, the chair legs, upper arm, coat collar, and the back of the

Fig. 101.

chair, and not a single line which runs in a symmetrically opposite direction; to the right we have an empty space, while to the left a vase and a table crowd the space and withdraw the eye from the main object. That the monotonous and unnecessarily parallel lines could have been easily avoided it is not hard to understand; but we must not think that we must avoid absolutely all parallel lines in a picture; we must leave what is an organic necessity, but we must not unnecessarily increase them, as the author has done in the preceding picture, by letting both arms, both legs, the legs and the back of the chair run in the same direction.

In conclusion, I will give a sketch in profile, after Paton (Fig. 102). The balance has been beautifully maintained; the folds of the dress, which fall towards the left, find their symmetrical opposite in the lines of the arms, which descend towards the right. The shrubbery at the right finds its opposite in the two trees on the left; a few objects in the foreground on the right side correspond with the figure and give it an easy appearance. The few branches and the hat in the immediate foreground are not without meaning. They form, so to speak, the continuation of the lines of the arms, which incline to the right. When we cover the former by a piece

of paper, the figure will at once lose its importance. If the child should stretch its invisible foot towards the right, the accessories would no longer be necessary.

FIG. 102.

I have shown in these examples how we can do justice to a free symmetry, or how we can maintain an artistic balance. The artist is at liberty to call draperies and accessories to his aid.

A piece of drapery thrown over the back of the chair of Fig. 101, and falling towards the right, would establish the artistic equilibrium, a trick which is cheap and very much liked. However, it would not remove the parallel arm and legs, but would only fill the empty space. The less an artist stands in need of these things the better he is off. That they are not absolutely necessary is demonstrated by the portrait (Fig. 98), which is copied from a picture by the world-renowned C. V. Jagemann in Vienna. The woodcut does not do justice to the original.

It shows symmetrical arrangement with full liberty of motion, and yet without resorting to draperies or accessories. In every arrangement one thing should be observed,—the arrangement must be free and unrestrained. As soon as we notice in a picture that the artist has carefully pulled the clothing into the proper folds, that he has dragged furniture and draperies to his assistance in order to establish an equilibrium of lines, when we feel that the limbs and the material are forcibly squeezed into a position which they would never assume naturally, then the arrangement appears artificial and inartistic.

The portrait (Fig. 98), as well as the sketch by Paton (Fig.

102), show figures which rest on the broadest basis; forms which narrow towards the top, like a pyramid.

This pyramidal arrangement we find in numberless works of art. Why does this arrangement harmonize the best with our feelings? It is because the pyramid rests on the firmest foundation; and we demand a firm stand for every figure at any price, particularly in photography.

This is a point which requires particular attention with standing persons; they are not so easily brought within the pyramidal arrangement, and hence are easily in danger of appearing in the picture as if they rested on an insecure basis.

We not only find this arrangement on the basis of the pyramid for single persons in the works of art, but to a much larger extent for groups.

I will give as an illustration a group by Bendermann.

We see the pyramidal arrangement not only in the whole group, but the large pyramid resolves itself into several smaller ones; for

Fig. 103.

instance, to the right the mother with the child; in the centre the boy with the jug, and where the stream of water accommodates itself to the pyramidal arrangement the lines of the right are the opposite of those of the left. The boy playing the flute comes

under the same arrangement. We see here that two things of secondary importance serve to complete the pyramidal structure, but the less we rely upon or resort to such artificial means the better it is. Such accessories become perfectly horrible when they crown the pyramid. I have seen a picture of two sitting persons where the pyramid was formed by placing behind them a step-ladder. In fact two persons are apt to give the photographer much trouble in the arrangement, and even the sculptor has great difficulties in properly disposing of such subjects. As examples I would mention the Schiller-Goethe Group of Rietschel and the Luther-Melanchthon Group by Schadow. The difficulty is still greater when a great number of persons has to be grouped together. This much is to be observed, the pyramidal grouping must appear easy and without stiffness; it must under no circumstances appear as if made after a stencil pattern, in which every object is forced into a given form.

There are objects which are absolutely antagonistic to the pyramidal form. As an example we give "The Last Supper," by Leonardo da Vinci.

FIG. 104.

It would hardly be possible to arrange the thirteen persons who sat at the table in pyramidal groups. A horizontal arrangement is unavoidable unless we foreshorten the table. The nature of the case demands it. The picture shows how the artist disposes of a number of persons, and brings them all prominently into view.

He proceeds like the naturalist. The latter, in order to make it comprehensible, divides a number of objects in genera and families, or smaller groups. In a similar manner the artist divides his persons into two principal groups,—six apostles to the right, six to the left; each of these two groups is again divided into two parts containing three persons each. But all the parts stand in a harmonious combination; they all arrange themselves in accordance with the idea of the picture. The arrangement obeys the laws of symmetry in the most perfect and easy manner.

FIG. 105.

There are works of art in which pyramidal composition was possible, but where it has been purposely neglected. Thorwaldsen's splendid Bas-relief, Night, is an illustration. With two sleeping children (Sleep and Death) the female figure floats down to the earth; around her forehead is a wreath of poppy, indicating sleep. We would have to force our judgment to find a pyramidal arrangement in this work of art. It would, in this instance, not only be superfluous, but it would also be without motive, for the figure does not demand stability (which is a characteristic of the pyramidal style), because it is not at rest; it floats in the air.

I have had engraved, as examples, several works of art of the highest order, to serve as patterns to illustrate the rules of art. In how far the latter can be applied to objects *which are taken from real life* a few more specimens may explain, such as Mieris and his wife at breakfast (Fig. 106), and a musical entertainment after Terburg (Fig. 112), also a loving couple after Metzu (Fig. 111).

Fig. 106.

When the photographer has to group a greater number of persons he can easily combine the horizontal and pyramidal arrangements. He divides the numbers, as in Leonardo's picture, into several smaller groups (which, however, must not be disconnected), and tries, in each of the smaller groups, to do justice to the pyramidal arrangement. It will be difficult for him to create a work of art in this way. People are too unwieldy and too awkward, but he will succeed in making a more pleasing group than if he placed all his figures stiffly side by side.

The arrangement of landscapes admits of much more freedom, as we have already seen above, in speaking of the sketch by Paton.

(Fig. 102.) The shrubbery to the right finds its symmetrical opposite in the two trees to the left.

In the same manner in a picture of the sea, which intentionally has been enlivened by a boat or a ship, the latter effect must be balanced by massive rocks (Fig. 107). Clouds also are often happily employed to produce this equilibrium.

Fig. 107.

Accessories are of great importance. Very often the simplest things are of the greatest advantage. For instance, the following two figures (Figs. 108, 109), for which we are indebted to Mr. H. P. Robinson, the unrivalled composition photographer. The two

Fig. 108.

wood-cuts represent one and the same object, and correspond exactly, excepting the black spots,—the boat in the river, and the

tree on the river-bank, which in the one are wanting. In comparing the two we feel at once the importance of the black parts in the lowest point of the angle, which is formed by the perspective lines of the castle and the river. In the second picture, where the boat and the river-bank are left out altogether, the castle looks as if the foundation had been removed from under it. The lines, which run towards a distant point, seem to lack union and regulation; the distance enters the foreground, and the separate parts do not stand in the proper relation to one another. In Fig. 108, where the boat, tree, &c., are present, every part occupies its proper

FIG. 109.

position, and we have a feeling of completeness which is wanting in Fig. 109.

I would advise the student to study with care the principal landscape pictures of our great masters,—Claude Lorrain, Schirmer, Lessing, Hildebrandt, and others. In all of them he will find interesting examples of what has been said above.

LINES AND OUTLINES.

Before photography was invented the so-called silhouettes were much liked as cheap pictures. They represented nothing but the outlines of the figure, generally in profile. Everything else was empty (as the treasury of the French minister (Silhouette) from whom these pictures derived their name). In spite of this emptiness the pictures were pleasing, and how much effect can be produced with

them is shown by the recent silhouettes of Konewka, who really has produced charming pictures in this branch, and the want of filling up in his pictures is scarcely felt. This shows of how much importance outlines are. The influence is felt everywhere, not only in the empty silhouette, but in every picture.

Every thinking artist who desires to reproduce an object first studies its outlines. He allows his eye to glide over the lines, and tries to find the beauty of their curves. He follows the changes of the stronger and the weaker one, the longer and shorter, their windings, and easy combinations. Let us study, for instance, the outlines of the figures of the Madonna Aldobrandini by Raphael (Fig. 110), one of the most magnificent early works of the great Urbini, let us place alongside a similarly arranged, and according to photographic notions, successful children's picture, and we will feel at once the enormous difference. But not only the outlines speak in the picture, but the whole contour generally, whether it be formed by the limbs, seams, folds, accessories, or draperies.

I have already shown above what an unpleasant effect is produced by parallel lines, or when the limbs are placed at right angles to each other, like the legs of a saw-horse. In every artistically beautiful picture there exists a wonderful degree of harmony of lines, and even a photograph can do justice to this.

Let me again refer to the picture by Jagemann (Fig. 98). The edge of the undercoat slopes from the right hand upwards, and is continued in the line of the neck. The latter sweeps on the other side downwards, in the contour of the face and the forehead, and is finally lost in the edge of the same coat. The outline of the hand which holds the book is, starting from the little finger, continued in the same elegant manner in the contour of the overcoat, ascends next to the throat, descends on the other side, and ends in the slightly curved index finger of the left hand, and almost voluntarily the eye follows the direction of this finger, and continues the sweeping line in order to ascend again to the edge of the book, the thumb, and the contour of the inner coat.

This shows how several outlines may combine to form a main line, and how even the hair may follow the sweep of the curves.

I would now call attention to the "genre" style of Terburg (Fig. 112), Metzu (Fig. 111), and Mieris (Fig. 106). In Fig. 112, for instance, we see the contour of the coat of the lady continued in the folds of the table-cloth, ascend to the corner, and continue in the right arm of the knight, continue again in the outline of the figure standing in the background, and thus gradually carried back

to the lady. The back figure in the terzetto would, if placed by itself, not be free from objection. *It is a fault when neither arm nor leg resolves itself into outline, and when the head is squeezed in between the shoulders*, as in this last-named figure.

Fig. 110.

Such figures are bad unless the action represented should demand such a position. But in trying to give a sharply-marked outline we can do "too much of a good thing," and instead of expressing calmness and dignity by a simple profile, we may, by too lively an arrangement of outlines, do exactly the reverse. We need not look far for examples. There are thousands of portrait photographs, in which the calm and dignified features of an old man are represented by zigzag lines, lacking all the elements of beauty

FIG. 111.

In its outlines, the picture by Jagemann (Fig. 98), may be called a success. Only one thing is annoying, the projecting back of the chair behind the left arm and the shoulders, which are drawn back too much, and give to the figure a weak appearance.

The lively outlines correspond perhaps with the character of the subject, but they would be ill-suited to an older person. A little more lively profile would be desirable for the female parts of the picture by Metzu (the lovers) (Fig. 111), but it may be objected that the beauty turns a cold shoulder to the caresses, and that the quiet outlines correspond exactly with her indifferent humor.

It is difficult to explain to any one fully the beauty of lines. It

is a matter of feeling. I can only call attention to the first-class masterpieces in painting and sculpture. For instance, the lines and general contour in the Madonna of Raphael (Fig. 110). In these wonderfully soft outlines, which look as if they were laid on the canvas with the breath, is such a charming harmony that everything which the photographer has ever made with his camera looks flat and weak compared with it. On such works the disciple of art may exercise his appreciation of outlines.

FIG. 112.

In landscapes also contour and lines play an important part. Even the ordinary admirer of nature distinguishes between elegant and clumsy outlines of mountains and trees. In architectural pictures many parallel lines converge towards the point of "disappearance;" they direct the eye to great distances, and even without such architectural lines we will feel, in a well-composed landscape, a certain harmony in the sweep of the lines, as, for instance, in the curve of the shore which is lost in the distance of the picture (Fig. 107); also in the contour of the mountains, all of which lead the eye to the same distance. Clouds are wanting in the above sketch; if an artist would add them to the picture their outlines would have to harmonize with those of the mountains and shore.

In the sketch of Windsor Castle (Figs. 108, 109) the outlines of

the clouds descending to the right form a contrast with the contour of the architectural objects which descend to the left.

DRESSES AND DRAPERIES.

Our climate compels us to cover ourselves, as a protection against wind and weather, with clothing, the form of which is regulated by sex, nationality, the age, and is also modified to a very large extent by the individual taste and fashion.

In general the modern dress consists of bag-like pieces, which are sewed or buttoned together—sleeves, pants, vest, coat—quite in contrast with the costume of the ancients, which consisted in simple pieces of some material which were thrown in picturesque folds around the body. At present the fop shows himself by the cut of his clothes, which correspond with the latest number of the journal of fashion. At the time when classic Greece had reached its height the greatest elegance showed itself in the beauty of the folds of the drapery. Pericles was celebrated for the manner in which he threw his cloak about his body.

We find the antique costume in numberless statues, and even where the figure is completely draped we can discern the form of the body distinctly. Shape and motion of the covered limbs are distinctly visible. To this principle, from which the ancients never deviated, our great modern artists strictly adhere, and where it has been overlooked the work will not even satisfy the common inartistic observer.

Our feelings demand motives. Why is there a depression in the drapery? Because underneath it is the cavity between the arm and the body. Why is there an elevation in the dress? Because it indicates the knee.

FIG. 113.

When we contemplate the (in itself) beautiful Maria, by H. Van Eyck (Fig. 113), we find the dress does not indicate in any way the foot, the leg, or the knee, and one cannot tell (at least not from the wood-cut) whether the figure is kneeling or standing. No one will call such drapery beautiful.

The forms are much more clearly indicated through the covering of the Madonna of Fra Bartolommeo (Fig. 114). It is not difficult to perceive that one leg is kneeling, while

the other one is stemmed in support. The position of the knee is clearly indicated. Even the heel of the left foot is plainly shown. Much the same arrangement we see in the arm.

How strictly modern artists conform to the rule that the folds

FIG. 114.

of the drapery must conform to the forms of the body is shown by the fact that the sculptors first model their figures naked, and afterwards place the drapery on. Some modern fashions make this conforming of the clothing to the form of the body, an impossibility in photography, as, for instance, the use of the hoop skirts.

In such cases the artist must submit to the ruling fashion, for it would be wrong to persuade a modern lady, not an actress, to discard her crinoline in order to mark by a suitable drapery the position of the knees, the legs, &c.

In the arrangement of the clothing and draperies, in so far as

the fashions do not interfere, attention should be given that the points of the shoulders, elbows, hip, knee and foot are recognizable, also the broad surfaces of the chest, the loins, &c. On the latter, depressions look very bad, while they are well suited to mark cavities, as, for instance, between the body and arm, between the legs, &c. (Fig. 114.)

How important a part the drapery plays, in giving a more or less elegant flow to the lines, the examples which we have given above will show. Good artists are always anxious to modify the baggy and unyielding forms of our modern garments, by a piece of cloth or a cloak, in order to drape the figure artistically, and the more stiffness the fashion or the clothing prescribes the more excusable is the artist if he resorts to these subterfuges. In the soldiers of Rauch we generally find the cloak (Blucher, Scharnhorst, Gneisenau), the flowing lines of which agreeably contrast with the stiff lines of the uniform, and which splendidly mark the movements of the figure. Photographers in particular like to resort to these accessories, and especially the sculptor Adam Salomon, who goes perhaps too far in this respect, by giving to his sitters draperies unknown to modern fashion. Fortunately cloaks, havelocks, and Scotch plaids are the ready means at the hands of the artist to produce the desired effects; still better advantages are offered in the female costume, where arabs, shawls, veils, &c., supply a variety of draperies. But they should not be given to persons by whom the wearing of such articles is unusual, and who, perhaps, even protest against their employment.

It is not the purpose of photography to represent motion, but on the contrary a resting pose, and, therefore, it loses that important element of marking the forms of the body which the artist possesses in the flowing drapery.

It must not be supposed, however, that the artist can let the garments fly about at will, but their motions must have a motive, which we must be able to explain from natural causes.

It is the resistance of the air in Thorwaldsen's "Night" (Fig. 105) which presses the drapery to the form, and brings out the beautiful proportions.

Such motives we demand also in a resting pose. Byron, by Thorwaldsen (Fig. 115), has his cloak over the shoulders, in order to hide the right half of the body completely. The hand rests on the knee, and this causes the folds descending from the shoulder to be tightly drawn, which with the depression between the arm and the upper leg, plainly indicates the form of the body.

Frequently we help ourselves artificially by purposely pressing the draperies into the cavity between arm and body, or between the legs, but such an arrangement has to be managed with exceeding care, in order to look artistic and not artificial.

The material of the garment plays a very important part. Starched linen and highly-finished silk give hard and unpleasant folds. Cotton is better, but woollen material is the softest and most harmonious.

The gloss, the color, and the thickness of the material, also require the most diligent study of the artist. For the painter, color and high-lights are welcome objects to show his skill. The photographer is often driven to despair by their stubbornness, as the color is either ineffectual, or the high lights produce ugly white spots. Salomon is right. Starting from the principle that the head should be brightest, he covers the light clothing which would make the head appear dark with dark drapery. He gives the preference to velvet drapery, not black silk velvet, but violet, brown, or reddish cotton velvet. This material arranges itself in soft and well-rounded folds, while the high light on the prominent points is gently moderated. A piece of dark crape or a veil is sometimes very valuable in modifying bright clothing, and has the advantage that the light dress shows through, while a dark drapery hides it completely.

Attention should be given to the parts without folds, and also to the elevated and depressed portions. The folds should flow evenly, and not be interrupted by numberless rumples, as is often the case when the garments have been in use for a length of time. I have seen a picture of Iphigenia, by Jagemann, where the classic robe was splendidly arranged, but where the many rumples disturbed the effect. The artist (painter or sculptor) leaves these things out, and he has a right to do so.

Folds generally do not run in straight lines, but appear on the curves of the body, or where the dress touches the floor, and the folds become broken.

Such breaks are very different in their nature; sometimes they are sharply cornered, sometimes more rounded, sometimes quite flat, and at others deeper. When they run in a zigzag line, backward and forwards, they disturb the feeling, and lack beauty (Fig. 113). The seam appears under as manifold aspects in our modern tiresome costumes; it generally is lost in monotonous lines, as, for instance, the seams of our coats, which are cut below in a horizontal line of almost architectural stiffness.

Still more disagreeable is the dress-coat, with the right-angled cut on both sides, which lacks all purpose.

But even in garments which fulfil the purposes of drapery much

FIG. 115.

better, the seam is generally neglected. The artist is often satisfied with having produced a few artistic folds, and pays no attention to the lines of the corners.

Of how much importance these are, a glance at the seam of the drapery of Thorwaldsen's Night (Fig. 105) will show at once.

Lively and animated at the feet, the upper parts sweep in various directions, and give rise to a charming play of lines. When such an animation of the seam is but an exceptional case in quiescent

figures, and particularly difficult in our modern costumes, still the pictures of Terburg and Mieris (Figs. 105, 106) teach us that with all simplicity we can avoid monotony. The lively curve of the seam of the cloak of Byron forms a pleasing contrast to the somewhat stiff and monotonous lines of his modern costume.

A peculiar kind of folds, which are particularly annoying to the photographer, are the folds which show themselves in our clothing after they have been in use for some time. They manifest themselves particularly in the arm and knee joints. They are elevations or indentations which are visible even in the standing figure, and which no pulling and twisting will remove. They are particularly offensive when they show themselves above or below the knee. Attention should be paid to these folds, and they should be placed at the spot where they properly belong, *i. e.*, at the knees or the elbows.

Sometimes a comical effect is intentionally produced by placing these folds in the wrong place, and by giving them a particular prominence.

The treatment which modern costumes require, in order to give an artistic effect, we can best learn from the works of modern masters. They should be studied whenever a chance offers itself. We should observe the contour, the folds, the surfaces, and seams. That is the only way to sharpen our judgment.

The hair requires similar management to the drapery, but in speaking of the hair I do not refer to the dropsical modern productions, consisting of chignons and other monstrosities, but refer to the free flowing natural article. I will not sit in judgment on every artificial curl, however. They are sometimes very acceptable in producing a picturesque arrangement.

The hair which hangs down monotonously without variation is like the drapery without a fold. The ancient sculptors enlivened it by pouring it into wavy lines. The effect is splendid when in nobly curved lines it flows around the head, descends to the shoulders, and harmoniously loses itself in the lines of the drapery. A hat with a waving plume or a veil will produce a beautiful harmony with the hair. The portrait painters of all times have known how to take advantage of this.

I might speak here of drapery in the landscape. Seriously speaking, what is the foliage of the trees other than beautiful natural drapery? The difference is that the trees wear their garments in summer-time, while men don their most elaborate costumes in winter. Here also the æsthetic sense demands that the skeleton of the trees, the branches, shall be visible in the foliage. The

elevations and depressions must find their cause in the disposition of the branches, and in this consists the difference between beautiful and ugly trees. In the former the contour of the foliage gives us an insight in the structure of the branches, although the latter are not directly visible.

THE ARRANGEMENT OF HUMAN FIGURES.

In the chapter on arrangement I have already called attention to the fact that, in a standing human figure, the centre of gravity must not be lost sight of. In a figure resting on one foot the line of the centre of gravity proceeds from the throat to the inner ankle bones of the foot on which the person rests. If the lines fall outside the same, then the figure is not sufficiently supported, and should have a support against which it can lean. A position where the body rests equally on both feet the artist will very seldom select, not even for a soldier. But where a body rests on one foot (Fig. 116), and where the other has free play, the hip on the side of the supporting leg will be higher than the other. It will also easily be observed that the shoulder over the supporting leg is a little lower than the other.

The hip lines and shoulder lines are no longer parallel. Painters pay particular attention to this, and photographers should do the same. There are persons who habitually carry one shoulder lower than the other. Such persons should not be placed in such a manner that the body rests on the foot which corresponds with the lower shoulder. The natural fault would only appear exaggerated. The head appears more lively when it has a different direction from the chest. The eyes follow the head; for instance, if the head is turned to the right the eyes will take the same direction, unless they should look straight ahead. *In no instance* is it admissible, where the face bears a calm expression, that the eyes should be turned to the right while the face is turned to the left. *By a very slight turn or change in the direction of the head on the one side and the apparatus on the other, the outlines of the head may become completely changed.* The turn of the head is generally left to the photographer, and he generally prefers to direct the eyes to the shaded side. Artists, on the contrary, are in the habit of turning the head in the direction of the highest shoulder.

The free leg, in contradistinction to the supporting leg, is not limited in the choice of position. It can be moved forward or it may recede, but the position of the opposite arm depends on the position of the leg. We notice in walking how the left leg cor-

responds in its motions with the right arm, and *vice versa*. The right arm and the left foot are raised simultaneously in order always to maintain the balance. But from an artistic standpoint it is likewise justifiable that the left arm and the right foot should move in contrary directions, so as to avoid parallel lines.

When the upper part of the "free leg" progresses, it is customary to let the upper arm on the other side recede and the forearm

FIG. 116.

progress (see the annexed figure of the Levite). Also, in order to avoid parallel motion, when one arm is raised the other hangs down by the side (see the annexed figure of the Pharisee.) In short, the natural contrast in motion, which shows itself in walking, we try to maintain in the *quiescent figures*, and this enables the artist to give it an animated appearance. Artists pay attention to the smallest details, even in the positions of the limbs. In an outstretched arm the hand should have a different direction from the

arm, and to the hand itself the most scrupulous attention is given. Next to the head the hand is the most expressive and interesting part of the body.

Beautiful hands are exceedingly rare, and the photographer is but too often compelled to show them as little as possible; but their natural ugliness is increased by an ungraceful position. Let us look at the hands by our first painters and sculptors. Every finger of the unemployed hand is independent and distinguishes itself from its neighbor by its motion, while in many photographs the fingers appear as if they were glued together (look at the figure of a grasping and supporting hand, Fig. 117; also the hands in the portrait, Fig. 115). We will also find in our masterpieces, without much difficulty, that the index finger plays a prominent part amongst the longer fingers of the hand.

Fig. 117.

It is difficult for the photographer to separate the fingers of his model. A simple expedient to give to the stiff fingers a somewhat more lively expression consists in placing a roll of paper in the hand of the sitter. The fingers will place themselves around this, similar to the portrait (Fig. 116). By gently removing the roll, the fingers will remain in a tolerably graceful position.

We must of course take the individuality of our model into account. It would be ridiculous to bring the horny hand of a laboring man or a washerwoman into such a position. The position of the hand depends of course upon the object that has been held by it. A light object, for instance, like a book, is seized more in a playful manner, while a heavy one, like a lance or a spear, is more firmly grasped; but even here the index finger does not grasp as firmly as the others. To seize a light book in the same manner as a heavy weapon would appear comical; and to seize a heavy weapon as gracefully as a plaything would appear weak.

All that has been said in the above pages in regard to standing figures applies, the nature of the support excepted, also to sitting ones. Both legs are here at liberty. On account of the inactivity of arms and legs there exists a greater freedom of motion and of arrangement. Above everything else a parallel position of the arms, or of the legs, should be avoided. Fig. 101 furnishes a warning example.

On the contrary let us contemplate the position of the arms and feet in the Agrippina (Fig. 118). In the practice of art we will fre-

FIG. 118.

quently be compelled to deviate from this rule, particularly when lively motion has to represent bodily or mental excitement.

With such representations photography has nothing to do; the representation of objects at rest is her province.

I must still call attention to the differences in age and sex. Children and women are differently constructed from men. They stand and walk differently. The child, for instance, does not know a supporting leg nor a free leg, except in a highly developed state. It stands firm on both legs. The masculine body is firmer, more muscular, and less fleshy.

In women and children the soft parts are more developed. Look at the hand of a child. It looks like a cushion. The large size of the head of a child is well known. The oval of the male head is broader below than the female. The eye in women is located a little lower than in men; the ears and the nose are a little shorter, and the mouth somewhat smaller.

Of course there are numberless exceptions to this average rule, according to race, individuality, manner of living, and development from gymnastic exercises. Place a woman who has to make her living with her handiwork, alongside of a lady who spends her time

in idleness. There are no two individuals exactly alike, and no one knows it better than the photographer. Let him try to repeat a pretty pose, with which he was successful with one model, with another person, and he will soon find the difficulties. It will not do, and in spite of all his care it will always turn out something different, even if the two persons look as nearly alike as can be. It is, therefore, generally speaking, superfluous to give rules for making positions.

I have repeatedly referred to the picture (Fig. 98) by Jagemann. The chest is turned towards the left upper leg. This gives a lively expression. It is increased by the turn of the head, in the reproduction of which unfortunately the xylographer has not succeeded. The whole figure becomes animated, which seems almost as if it were carried too far, but which in this instance corresponds exactly with the character of the individual. It would, however, be foolish if we would give a similarly animated pose to another person of a calmer temperament.

Slight contrasts are by far preferable. When a stiff-jointed old man places both his legs in parallel lines, we must admit that this is perfectly in order, and a quiescent turn of the head should be selected for him.

What has been said in regard to single persons applies with equal force to groups, for a group is nothing but a number of individuals. Yet in the arrangement of each single figure the complexion of the whole must be kept in view, and the building up of the group must be carried on in an artistic manner. The larger the number of persons, the greater will be the difficulty, and we have to add to this, that besides the artistic conditions, we have to take into account the optical difficulties, which require that every character should appear on the ground-glass sharply defined and without any distortion, the latter compels us to adopt a circular arrangement, where the concave side of the circle is turned towards the lens. When this is done the marginal figures will appear sharp, as the whole picture is now flat. How much the circle must be curved inwardly depends entirely on the nature of the objective, which yields more or less curved pictures. How the groups are to be artistically arranged we have already shown above. With all pictures without exception clearness in the arrangement is demanded.

When in groups the hands rest on different shoulders, an arrangement much in vogue in student's pictures, and where one is at a loss to say to whom the different limbs belong, and when the legs of a group form a confused mass, we must call the arrangement

confused. Such want of clearness very often happens also in single portraits, when for instance, one hand lifts the drapery and causes characteristic folds; but when the lifting hand itself is invisible, we must call the representation devoid of clearness. It further lacks clearness when expressive parts are covered up. It is mentioned as a fault in the group of the Amazon, by Kiss, that the three heads—the head of the Amazon, of the horse, and the panther—cannot be seen from any side all at once. It is also a fault to cover a limb which performs a characteristic function. I know of a picture where it is intended to represent a letter-writer, where the writing hand is covered entirely by a superfluous book. It is also unpardonable when the supporting leg of a figure, which gives it a hold, is hidden or partially hidden by unimportant accessories; this is even annoying in lifeless objects, as a table or a pillar. But it does not follow by any means that all the legs must be absolutely visible. For instance, in Raphael's "School of Athens," which is very rich in figures, the covering of the less important figures by the more prominent ones in the foreground is explained by the nature of the case.

CHARACTERISTICS.

We have spoken repeatedly of characteristic features, motions, limbs, &c., and the reader will ask, What are characteristic signs? I call all external signs that are *necessary* to a *true* and *comprehensive* representation characteristic.

For a letter-writer the writing hand is of course characteristic, even when it is not in the act of writing, but is merely lifted while the writer is in a contemplative mood, and the representation would be faulty and incomprehensible if this hand were hidden, even if the figure were surrounded by piles of paper and rows of inkstands and sandboxes. Sometimes for a clearer definition of the characteristics of the subject other marks have to be added. How, for instance, could we characterize a wine-drinker without a glass, a gambler without dice or cards. Some people think that they can get along with these accessories alone. We have, for instance, a representation of young Bacchus, with lifted and foaming champagne glass, but alas the face is cold and dry; the model shows that it is nothing but a model, and the features indicate that the fluid in the glass is nothing but small beer.

Such a representation is not only difficult to understand, but it is also untrue. A woman who folds her hands does not pray unless the expression of her face indicates this. This holds good also for

ordinary portrait representations. Observe the photographic portrait taken with top-light (page 242). The fierce-looking eyes and the heavy compressed lips are false indications, for they indicate a temperament which the man does not possess. Neither does the front and side-light illumination give the character of the person. A great artist needs very little to indicate the character, but the photographer often requires a great deal. That is the distinction between art and photography. The painter pays attention to the characteristic points only, while he modifies the others or leaves them out entirely, and the mechanically working photographer produces everything, even the minutest trifles, with equal distinctness.

Nearly every person has his own character—*i. e.*, his own principles of action (some, however, have none whatever). Some act without any forethought, quite unconcerned about the consequences. They think lightly of even the most serious things, and look on everything from the most cheerful standpoint (optimists), while others again look always gloomily into the future (hypochondriacs).

But in a picture we must represent the true character of a person, which can be done in a twofold manner. We either represent the figure at rest (as the statue of Lessing), or we represent it in action (Luther). It has often been said that the portraitist should not paint action. This is very true; but when action contributes in such a weighty manner to rendering the character of the person, as the features in Rietschel's Luther (Fig. 119) indicate, our objections are hushed in admiration. It seems as if this man of metal, this giant mind, thunders to every one his "Here I stand. I cannot do otherwise. God help me. Amen."

When Luther here as a hero stands divinely grand before us, we must say that this representation is justified, even when we are told that he did not wear the gown, but was simply clad in the costume of his monkish order, with his head shaved according to its regulation, and that at that time he was as thin as a match. If Rietschel had confined himself closely to these facts, he would have represented an Augustine monk, but not a Doctor Luther. Rietschel in his representation of Luther has departed from historical facts, but gained largely in characteristic effect.

The artist often has to struggle long and hard to find the characteristic representation of a historical or mythical figure. For centuries they struggle, and always in vain, until at last a god-inspired genius seizes the problem and solves it in such a forcible and convincing manner, that the form becomes a model and an ideal which is imitated over and over again, until finally it becomes the *type* of

the character. So the Zeus and the Athene by Phidias, and the Hercules by Lysippus.

Fig. 119.

Few people have features which clearly and unmistakably represent their character. Physiognomists are badly at fault. I know persons whose compressed lips have something sly and malicious, whose small greenish eyes have something false and treacherous in them, and still they are the best and most amiable persons, whose character and life are without fault or blemish. While, on the other hand, persons with open and noble countenances, who at first sight will win the confidence of every one, very often prove to be the

greatest rascals. A great many people run about whose faces are living lies. They enter the studio of the photographer and he shall make a picture of them which not only gives the outside appearance, the likeness, but which also indicates his *character*, which latter often contrasts in the most heterogeneous manner with his outside appearance. Few persons are aware how much belongs to the *complete* representation of a person.

Some appear charming when they talk, sing, or gesticulate. Some represent themselves only to advantage when they are in company, with a large circle around them listening to their witticisms. Some are only gay and lively in ladies' society, while others again show best in male company. Some people appear dark and gloomy in the room, while they are lively and amiable in the open air. The honest countryman feels depressed and embarrassed when he treads the elegantly carpeted floor of the richly furnished atelier, but he is happy in his humble cot. All these circumstances, however, have their influence on the appearance of a person. The portrait, no matter how good it is, will only give an *extract* of the character. It may appear a speaking likeness (scarcely a singing one), but it will only give partial satisfaction, as the accessories which the original requires to produce its whole effect are wanting. The painter, who knows his original, does not always succeed in this; how much more difficult must it be for the photographer, who has to represent a perfect stranger, who sometimes intends to leave in the next train, and who in his whole behavior shows so much hurry that he would make a good representation of Mercury with winged sandals on his feet.

To this we must add the circumstance that a great many do not care particularly for a true representation of their character. The rascal wishes to appear as an honest man; the lady passing into the sear and yellow leaf of autumn wants to be young and coquettish; the servant girl wishes to represent the mistress; the daughter of the mechanic wants to look like the court lady, and the street-sweep would be a gentleman. So do their pictures serve them as a gratification of their personal vanities; and in order that they may appear very fine and extraordinary, they put themselves into their own (and sometimes borrowed) Sunday clothing, which sits upon them as uncomfortably as possible. They practice before the glass, consulting papa and mamma, wife or sweetheart, on artistic, impossible pose. Even educated persons have such "cranky" notions. Thorwaldsen relates of Byron, who visited him to sit for his bust, that "he placed himself in the chair, but the moment I

commenced to work his features changed. When I called his attention to it, he remarked, 'This is the true expression of my face.' I made no reply, but finished his portrait as I saw proper. Everybody declared my bust to be a perfect likeness except Byron himself, who exclaimed, 'The bust does not resemble me; I look much more unhappy.' He wanted at that time to look very unhappy," continues Thorwaldsen.

The photographer is much worse off than the sculptor or painter. Suppose Byron had gone to a photographer and placed his woful face before the camera. What could the photographer have done? Unfortuantely he has at the decisive moment to depend on his model, and how often his model at this critical moment disappoints him, not always from ill will, but often from nervousness.

Much depends on the photographer himself, who should understand how to govern the public in an amiable manner, for the treatment of the public is no unimportant part of photographic æsthetics.

Generally speaking photography has to represent objects in a position of rest, and only occasionally do we find representations of still-life, where the figures are employed in a harmless activity, be it reading, writing, or contemplating a picture, mechanics at work, musicians performing on instruments, or children at play. In representing such objects the photographer can only seize a certain moment, and it is of the greatest importance to know how to decide which moment to choose. Not only artistic arrrangement has to be consulted, but contour and harmony of lines must be studied. Take, for instance, a smith wielding the hammer, or a sculptor with his chisel. He places the chisel on the block of marble, lifts the hammer above his head, and with a heavy stroke it descends on the chisel. It would appear very weak if we would represent this last moment, when the hammer touches the chisel; far much truer, more lifelike, and comprehensible would it be to place the hand with the hammer above the head in the act of striking. In the simplest motions, even in walking, we observe similar deep-seated differences. Not every phase is equally comprehensible. Many no doubt have seen the walking figures in instantaneous pictures, where the one leg is stretched forward in the act of stepping. Although this motion is entirely natural, and forms a part of our motion in walking, still it does not appear characteristic, but almost comical; it rather gives the impression of a military exercise.

Our walk is rather a complicated motion as simple as it may appear to us. We step forward, the weight of the body rests on the

Fig. 120.

forward foot; at the same time we elevate the heel of the other foot; we lift ourselves on the toes of the rear foot, and give the body a push forward, which is the real cause of the forward motion. When this has been done, we force the rear foot forward, and the same thing is repeated over again. Of all these different movements, the one which causes the forward motion is the most interesting—*i. e.*, where the toes of the rear foot push the body forward, while the forward one rests firmly on the ground and supports the body. And this is the position which artists select in the representation of walking figures. It is on the one hand the most characteristic, while on the other it gives the firmest position to the person so represented.

(See Thorwaldsen's Triumphal March of Alexander, Fig. 120.) A number of walking figures are here represented, and one would have supposed that for the sake of variety the artist would have selected different phases of the walking motion, and still we see all the figures in the movement where the rear foot is in the act of being lifted from the ground. Something similar we find in Konewka's Scene from Faust. Only the two soldiers have a very characteristic and for them suitable military walk, with both feet stretched forward. Solemn processions characterize themselves differently. In the Triumphal Frescos of the Parthenon, the female figures step on both feet. It

shows how difficult it is to characterize even simple motion in the picture.

The characteristic representation of mental condition is still more difficult. Foerster calls attention to Bendemann's Jeremiah. (Fig. 121.) The intention was to represent a person deeply grieved ; but the circumstance that the hand does not support the head, but simply pushes it sideways, gives to it more the character of an angry person, or one that suffers bodily pain.

The same author remarks very pertinently, "How unnatural the picture of a praying person would be who would not bend her head

FIG. 121.

downward, but hold it stiff and vertical, and where the hands only lightly touch each other, instead of being folded." Such figures remind one of the coquettish sinners, who go to church as a place of rendezvous, and who show that they care more for their surroundings than for the worship of God. Such studied positions are very common in the photographic representations of real life. The models feel their importance, and it is very difficult to prevent them from taking affected positions.

Most particular care should be taken with actors and actresses. These persons think that they understand everything much better than the photographer, as they themselves are "artists," and have made a study of beautiful positions and motions. Unfortunately, however, they know very little of the plastic art, and forget entirely that what may look well on the stage will look very bad in a picture. On the stage much can be well excused. Even a movement, which is not exactly beautiful, does little harm, as it occupies but a few seconds of time; but it becomes horrible when it is immortalized in the picture. Pictures of "mimics," who, when they wish

to remove a glove, stretch out the arm as if they were pulling the sword of a giant from its scabbard, appear absolutely ridiculous.

Many figures which painters draw from the living model lack beauty. Stone-throwing giants (where the want of all muscular exertion shows that the heavy rock is but a piece of wood) give no satisfaction.

Finally, I wish to call attention to how much the drapery is dependent upon the motion. For instance, see the person playing the "tuba," in Thorwaldsen's Triumphal Procession (Fig. 120). In consequence of inertia on the one hand, and the resistance of the air on the other, the garment in walking will fly backward.

We find something similar in the modern costume. Nothing shows more untruth than a photograph of figures apparently in motion where the drapery hangs down to the body. Such motions, which to characterize them require flowing draperies, are not suited for photographic representations. When the photographer wishes to represent motion, he should choose close-fitting garments for his figures. This is the reason why the photographs of mimic artists or ballet dancers appear in a measure dead-like and rigid, when it is intended to represent them in action.

But whatever may be chosen in order to give character to the object, everything that is not in itself beautiful should be avoided. The antique artists have never represented a fury, says Lessing, and the head of the Medusa, whose horrid countenance was to turn everything into stone, looks yet beautiful.

The beautiful cannot be learned by heart, as a rule in arithmetic. The feeling for it is a natural gift, and study can only develop it. It cannot create it. There are plenty of photographers whom nature has sadly neglected in this respect. They may learn at least what they will have to avoid, from what I have said, and when they feel that they cannot create, themselves, they should take examples of acknowledged value as their patterns.

THE TREATMENT OF THE PUBLIC.

Many persons have a great aversion to being photographed. They compare it with a visit to the dentist or the barber, and many a one would much rather be for half an hour under the hands of the latter than under the care of the photographer. It frequently happens that a person will resist the importunities of his friends for years, and finally walk to the gallery like unto a place of execution. Others, and to this class the ladies belong in particular, have no such strong aversions, but they are timid and nervous

when they enter a glass-house, and are not in a condition to make a good picture. Nervousness is by no means confined to the handsome sex, or to the old and feeble. Young and strong men get sudden attacks before the camera, and brave officers and soldiers, who would steadily march up to the cannon's mouth, will tremble before the photographic lens. They can no more stand still than any one else.

As this feeling is so widespread, the artist should attempt to dissipate it, and try to make things pleasant to his customers. The few introductory remarks on the arrival of a visitor he should try to make as agreeable as possible; neither too familiar nor too humble, but in the light and easy manner of the gentleman. During the preparation the same easy and polite manner should be maintained.

Under such a treatment many persons will lose their nervousness, and instead of having an aversion to the operation, it will afford them pleasure. This shows itself in the pleasant expression of the portrait, and in the carriage and quietness of the original.

It is probable that many photographers have never thought of the importance of such a treatment, and they must blame themselves if people do not like to visit their establishments. A rough and violent, or impolite and affected manner, we frequently meet with among our colleagues. Many photographers will call out, when everything is ready, "Please look at this point; but make a little more amiable face." A lady will not be pleased with such an expression, for it indicates that so far she has not looked amiable, and after so *polite* a request she will not look any better. "*Not quite so serious*," would be less offensive. Much also depends on the manner in which it is said.

Another point which severely tries the patience and good humor of the photographer is the head-rest.

His sitters, almost without exception, misunderstand this object, and dislike it. But head-rests are necessary, and it requires tact, firmness, and good humor in insisting on their use. The general remark is, "I will look better without it. It only makes me look stiff." The best answer would be, "You may perhaps feel stiff, but you will not look so in the picture." It is the general custom to request the person to look steadily at a certain point, and it gives a calm expression to the whole face.

Sometimes, and particularly during a long exposure, the expression will change during the thirty or forty seconds of time, and pass from a pleasant smile to a melancholy look. Many a photographer opens his lens on a laughing seraphim and closes it on a

fallen angel. It is, hence, necessary to caution the sitter against changing his expression. The corners of the mouth are particularly liable to this change.

Sometimes people will insist on having their pictures taken in unfavorable weather. They demand a trial, although the photographer feels perfectly convinced that it is but a loss of time and useless, and that success is impossible.

The photographer should remind such persons that it is in their own interest to postpone the sitting, that it would only give them unnecessary trouble, and that he has no selfish motive in making the request. Some people will bring a friend along, who wants to represent the *artist*, and assist in arranging the sitter. A young lady, for instance, will be accompanied by a young gentleman—a brother perhaps; perhaps somebody still dearer—to whose judgment she appeals, while the photographer places her in the proper position. The young friend commences to give advice how and in what direction his "protegé" is to look, generally requesting her to look steadily at a given point long before the photographer is ready. To a good photographer such an interference is unbearable. He finds his presence ignored, his place usurped by another, and feels that no confidence is placed in his artistic feeling nor in his skill. Here it is necessary to maintain your position, and to declare in a firm, collected, and polite manner, that either the photographer or the friend must withdraw. That a division of labor is not admissible, and if the gentleman wishes to make the arrangement, he may do so, but the photographer will not answer for the result. This has generally the desired effect, and the friend who perhaps never intended to become intrusive will generally withdraw.

Occasionally some one will insist quite obstinately that he wishes to be taken in a "comfortable" position. People often think that everything which is comfortable must be naturally graceful and beautiful. They throw themselves into the chair in a position which on the picture would give to them the legs of an elephant and the head of a dwarf. When such people are stubborn, it is best to let them have their own way. They will not try it a second time.

With all these trials and vexations to which the whims of the public expose the artist, it is not always easy to keep an even temper, and still he has to do it for his own sake and for the sake of his customers. It is not surprising that sometimes the stupidity of his clients puts him in a bad humor, for there are occasionally extremely provoking cases. A lady, for instance, will

return her cards without stating any reason, and after repeated inquiries she will state that she does not like the position of her hat, or that a curl should fall forward instead of backward; another will complain of the position in which she has been taken, and threatens to bring her husband along the next time for the sake of keeping control.

Another unpleasant kind of customers are those who want to be photographed with small dogs on their laps, or large ones by their side; but worst of all are small children. These little screamers are generally accompanied by papa, mamma, and nurse, who all come to "help" the photographer. The scenes which at such times happen in the atelier would be amusing if we would not lose our patience.

It is very necessary not to keep our patrons waiting too long if we desire to keep them in a good humor.

Waiting under any circumstances is a tiresome business, and many a picture shows but too plainly the long waiting to which the model has been obliged to submit.

Any one who has a flourishing business will do well to make an appointment with his patrons beforehand. Care should then be taken *that everything is in readiness.* Whoever commences to make the developer or even the silver-bath when the public is waiting will soon lose his custom.

Messrs. Loescher & Petsch prepare the plate the moment the model enters the atelier (the arrangements about the style of the picture having been fixed beforehand in the reception-room).

In the few moments of conversation, which precede the taking of the picture, the photographer should have sufficiently examined his model and formed his conclusions about position, illumination, arrangement of dress, background, and accessories. He must at once arrange the pose while his assistant arranges the camera and brings the lens in focus. Only when the plate is ready the rest should be gently adapted to the head (not the reverse). With a quick glance the whole arrangement should be examined to see if illumination, outline, drapery, and background form a harmonious *ensemble*, and then the work should proceed at once without delay.

Any third party, or any noise in the adjacent rooms, running, to and fro, &c., is an annoyance.

It is inconsiderate in the extreme to place the person in the head rest, and to let them wait for the plate, or to lose half an hour in making the proper arrangement, and to change the position over and over again. The person will feel that the photographer does not know exactly what he is about, and will lose confidence.

Children should be taken very quickly. Success with them is in a measure a matter of chance. The light should be strong, the lens should work rapidly, and while the artist draws the attention of the little one by showing a toy or some bright object, the assistant should remove the cap the moment the child sits quiet.

Any one who has much intercourse with children will soon learn their little peculiarities, and by adapting himself to them he gains their affection, and they willingly obey his arrangements. This is the reason why a friend of children like Mr. Petsch is so successful with them.

FILLING UP THE PICTURE.

ACCESSORIES AND BACKGROUNDS.

In photographic practice certain sizes have become standard, and they are ordered over and over again. Particularly is this the case with the carte de visite size, and also the cabinet size. Both these sizes are dependent on the lens and plate-holder of the camera. The photographer has to see to it that the space is properly filled.

When, in 1858, Disderi, in Paris, invented the carte de visite, and by it gave an enormous impulse to photography, he recommended to take full-length pictures as being artistically most justifiable, as figure and deportment are necessary to the characteristic of an individual.

Photographers generally made whole-length figures in the beginning, and only here and there a bust or $\frac{3}{4}$ size would make its appearance. It did not take, a great while, however, and busts became more and more in vogue. The public liked them. The reason is obvious. A picture in which only the head and chest are visible cannot be spoiled by a faulty arrangement of legs and arms, nor by an ugly arrangement of accessories, as too often happens with full-length pictures. So far as the æsthetic element is concerned, their production is easier and surer.

To this must be added other advantages. The larger dimensions and the greater prominence given to the most characteristic part of the human body, the head. Delicate details in the features, which in the small full-length picture were only visible with a magnifying glass, become strongly marked (sometimes too much so) in the bust picture or vignette.

On the other hand, individual shortcomings and faults in the illumination, which would scarcely be noticed in the full-length

picture, became quite apparent, and it was reserved to a later period to remove them.

Since this size has become quite fashionable, various experiments or improvements have been attempted by enterprising photographers, which have gained a more or less general approval of the public. At first, heads of a size from $\frac{3}{4}$ to 1 inch, and where more or less of the bust was visible, were all that was ventured. Soon the size of the head was increased to $1\frac{1}{2}$ and 2 inches, apparently at first in England, for the first cards of this kind which came into my possession were portraits of Boz (Dickens).

Although many objections might be urged against the adoption of this size, still it has become more and more popular. I cannot help stating though that it is less suitable for the general public than for the heads of the ladies of the stage, with their rococo style of hair-fixings.

No doubt the unusual size of the head will show a richness of detail, as buckles, chains, chignons, curls, &c. But on the other hand, the danger is obvious that some undesirable details, as wrinkles, freckles, &c., become unpleasantly prominent in the picture.

The ladies of the stage have other means at their command to cover such shortcomings. They are in reality the inventors of a third kind of retouch, which, to distinguish it from positive or negative retouch, we have called the *original* retouch, as it is with paint, poudre de riz, and rouge, applied on the person itself, and at present this kind of retouch is in many of the Berlin ateliers (not only by ladies of the stage) practiced with good success.

With these large heads a careful study of illumination is of great importance. To this we must add negative retouching, which for obvious reasons becomes oftener necessary than in pictures of smaller dimensions, not to speak of removing spots.

Still another important element is the lens with which the picture is to be taken. On this point we have given above (page 257) some directions.

For the general photographer bust pictures without a background (vignetted) are doubtless the most convenient. Legs are excluded, and generally the hands also. He has no difficulty with the position of these extremities. He should pay attention to head and chest (see pages 286 to 291), the upper parts of the arms, a pyramidal arrangement, and outlines. The figure itself is generally seated, being more steady than the slightly vibrating standing figure. The background should offer sufficient contrast that the outlines may

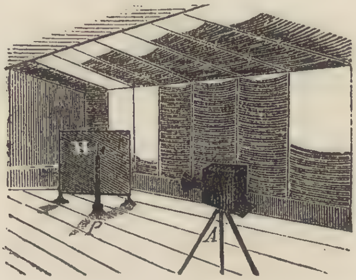
not run together, but stand out boldly. For black hair there should be a somewhat lighter background, and for light hair a somewhat darker one.*

Lately, instead of the white graduated backgrounds, gradated ones and even black ones have been introduced—*i. e.*, the so-called Rembrandt backgrounds.

Mr. Kurtz and Mr. Baker have made the start, and I have seen pictures made by them in which almost the whole face is kept in a half shadow, and where the eye, contrary to the generally adopted and recommended usage, turns towards the light instead of the darker side, and this style is now quite general in America. Mr. Milster and Mr. Petsch, in Berlin, have likewise adopted this mode of illumination, but they employ a light background, and in so far they differ from the "Rembrandts." The following sketch by Mr. Grasshoff will explain the mode of making them.

A is the apparatus, *P* the person, *H* the background. The management of the side and top curtains is plainly visible in the cut.

Fig. 122.



The illumination must, as Mr. Grasshoff distinctly states, vary with the person; accordingly more or less curtains are opened or closed, and the camera is moved more to the right or left, as shown in the ground plan (Fig. 122).

Special effort should be made to have the shadows well lit up. It

* It is certainly remarkable that the glaring white backgrounds in vignetted pictures does not offend our feelings, while otherwise we are horrified at every high light in pictures with a full background. We can only explain this by the circumstance that our æsthetic feeling does not consider the white background as belonging to the picture. It appears to us as a part of the white paper, but not as an organic part of the picture. It is quite different with full backgrounds with designs on them. They pretend to belong to the picture, and are judged as parts of the same.

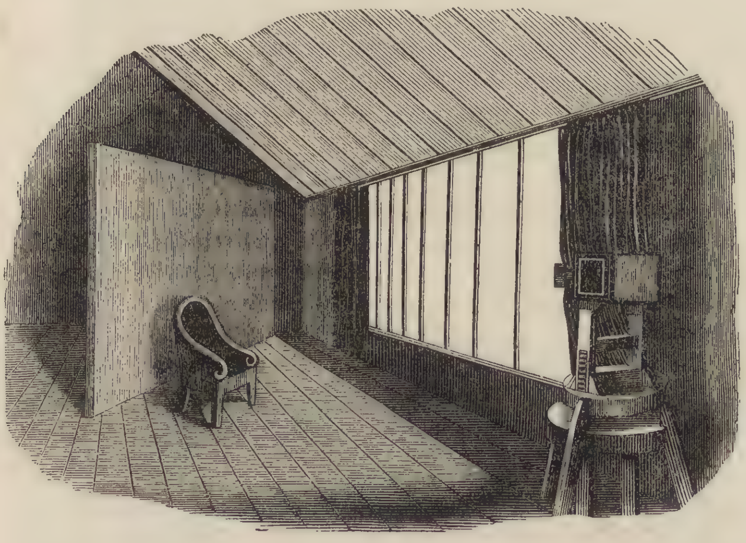
might be said with much propriety that nature is not as black as shown in the "Rembrandt." This is very true; but we may say with the same propriety, that nature is not as white as represented in the toned pictures. However, the brown foundation as background to the picture has already in antique painting (Pompeii and Rome) done good service, which in modern times has been happily imitated.

Our modern painters too have monotonous, half-dark surfaces without any design, as backgrounds, only they treat them differently from most photographers. They appear unequally illuminated, dark on the side from whence the light proceeds, and light on the side of the shadows, and this is why the figure itself is plastically relieved from the background.

Such unequally toned backgrounds are obtained by shading them with some object, which is not visible itself in the picture.

Attention should be paid that the shadow be cast in such a manner that the illuminated side of the model is cast upon it,

FIG. 123.



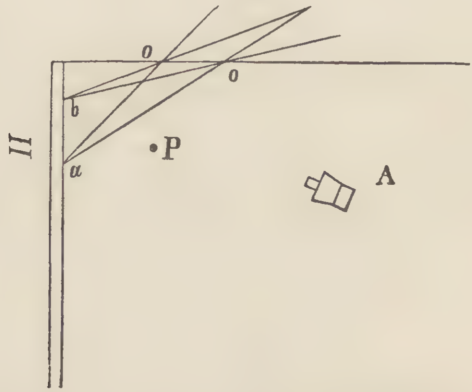
while the background behind the shadow side of the same remains light.

Adam Salomon, in order to obtain the same result, inclines his background.

Finally, we can effect the same result by raising next to the person, P, a single curtain, O O. The different parts of the back-

ground, *H*, appear unequally illuminated. *b*, for instance, although the glass side is nearer to it, appears darker than *a*, as is explained by the angles of light indicated in the figure. It is easy, by placing the apparatus *A* in a suitable position, to obtain the desired result. In order to light the shadows properly, a considerable quantity of front-light is necessary.

Fig. 124.



With bust pictures it will seldom be necessary to bring in other objects than the individual. It alone will fill the space, even if the whole background should be printed in without any effort at vignetting.

It is different with three-quarter size or whole-length pictures, or when the body is in a sitting posture or when it supports itself; then a pedestal or a stand is necessary, and we also require a floor. Even in such cases we do not hesitate to employ a monotonous background, and the care of the artist is confined to the chair, the floor, or the support (the table).

It is also necessary to observe that accessories must harmonize with the main figure (see Arrangement, Contour, and Lines), and they must, because they are accessories, be secondary in importance to the main figure—*i. e.*, they must neither in shape nor in color become too prominent.

High lights on furniture are horrible, but much more so are zigzag lines or ornaments which interfere with the harmony of the outline. A glaring design in the carpet or curtain is unbearable.

When these simple things offer already so much difficulty, how much more complicated must it be when the whole background is filled up with obtrusive painted landscape scenery or architectural

objects. We can operate with real objects; we can place the figure in an arbor, in a window, or have a really papered wall, where everything which is necessary to the picture has been suitably selected and placed in the proper position. Or we have recourse to a painted background. There are many of them, which can be purchased from the stockdealer, but most of them are good for nothing.

One of the most striking shortcomings of the painted background is the accumulation of different objects and the diversity of the things so introduced; the number of the objects, which by their smallness are to indicate the distance, while the sharpness and solidity with which they are painted places them immediately back of the sitter, and the perspective becomes at once wrong when the camera is not placed at the eye-point of the picture (see page 252).

It is perfectly clear that if natural objects are at all represented in the background, it should be done under the same conditions as the principal figure itself, and that the landscape should not have a different "eye-point" from the model.

The horizon, if it is represented at all, should be opposite to the lens. For a time it was the fashion amongst portrait painters to paint the horizon as low as possible. Of course the figure reached to the clouds, and appeared very gigantic; still, such a picture looks very untrue.

I will give, as an instance, the picture of King Frederick William. He stands on the sandy plain, and in the distance is "Charlottenhof," *reaching as high as the knees of the figure.* Such a view could only be natural when the painter places his head on the ground, or when the figure stands on an eminence and the observer below. Reutlinger has made some good pictures where the figures reach to the clouds; so also has Robinson. The undefined cloud forms relieve the figure, and it is easy to place the light face against a dark cloud, or the dark hair against the light sky. But the horizon should not extend lower than the hips.

A faithfully drawn landscape, but without much detail, and which contains nothing which will draw attention to lineal perspective, in which, hence, *horizontal lines* are as much as possible avoided, will always be effective, and need not contain any gross errors, even if it is not absolutely true. Some backgrounds of Graf and Reutlinger show this in a remarkable manner.

Regarding the illumination of backgrounds, it may be difficult to get a perfect harmony between the illumination of the sitter and the objects forming the background. It is also necessary to change the illumination with the different models. Some require more

top-light, others more side-light, while the illumination of the background remains unchanged.

This causes difficulties; but when the backgrounds are originally painted in a manner to correspond with the general illumination of the room, and when light and shade have not been placed in too violent a contrast, it becomes easy to avoid any striking errors. In landscape backgrounds top-light should predominate as corresponding with an open air effect, while for an indoor representation a side-light effect would correspond better with the light entering a room through the windows. It would of course be very bad taste if the sitter received the light from the right side, while on the background the light is painted as coming from the left.

I sometimes meet with queer combinations on the background. Papered rooms only separated by a balustrade from a rocky coast or a desert heath; ladies in a ball-room toilet amongst rocks and under a threatening, stormy sky,—follies which spring from thoughtlessness, and to which I need only give a passing condemnation. I must also condemn a combination of different styles of furniture, as gothic, renaissance, or rococo. Attention should be paid to style.

A *real* plastic decoration, as a pillar, a clock, a moulding, or a picture, will always be more effective, when the color has been properly selected, than a painted representation of the same object in which we always notice the pasteboard, not to speak of the incorrect perspective.

Lœscher and Petsch have for this reason introduced real objects in the background in place of painted ones.

In the large cities it is easy to procure good backgrounds; but in the smaller towns the matter becomes more difficult. The photographer orders according to a sample. The sample looked very pretty and full of effect, but in using it everything turns out entirely different. What is to be done now? To alter it is difficult, hence it remains as it is, and awful things come to light. Still the fault is with the photographer. The sample was taken under entirely different circumstances.

When some parts work too glaring, Mr. Grasshoff recommends the following background retouch: Some powdered yellowish-brown color, as, for instance, gold, or Roman ochre, or umber, should be placed in a piece of linen in the shape of a pad. With such a contrivance the light places are rubbed over, and the yellowish tone will produce a more subdued effect. In a similar manner spots that are too dark should be retouched with pulverized

chalk. This will often be sufficient to harmonize effects, which are otherwise disturbing.

In conclusion, I will add some valuable hints from our friend Mr. William Kurtz, in New York:

"We frequently meet with the same background in twenty different pictures hanging in the same showcase. The different persons are costumed in the greatest variety of styles, but the background alone is sufficient to show at whose atelier the pictures originated. This is, plainly speaking, simply *manufacturing* pictures, and out of ten pictures perhaps only one has a background correct in tone—*i. e.*, in only one of them face and figure contrast harmoniously with the background. This holds good not only when plain backgrounds are used, but more particularly when those that have fancy paintings on them are introduced.

"The photographer should never forget that he must produce his effects by entirely different means from other artists, and it is better to execute in the best manner what legitimately belongs to photography, than to expect great results from innovations devoid of any artistic intention. *When we have a wide background and much space in front of it, we can place it nearer or further off, and by making it lighter or darker get the color most suitable to the sitter.*

"The best fancy backgrounds which I have seen came from Paris. The figure stood out well from a boldly painted park scene, which possesses on the one side a handsome light effect, supported by a splendidly executed, although little detailed, patch of foliage. The foreground suits exactly, and consists of natural plants, stones, &c.

"A picture representing a lady, full length figure, gave the impression that the background had been expressly painted for the picture, the two harmonized with each other so excellently. Unfortunately, however, this was only the case in this single instance. In some—there were perhaps altogether ten or a dozen pictures—the background was too dark; in others it was too dull. However, let us return to the consideration of the simple background for heads and busts. That we cannot employ the same background for everybody seems self-evident. There are many rules given on this point, but generally speaking it is a matter of feeling.

"For heads and busts a medium gray background of woollen material is sufficient; in accordance with the position of the same to the light, various shades may be obtained. Sometimes pictures are condemned merely on account of the background, as it inter-

feres with the '*likeness;*' when, for instance, a blonde is placed in front of a light background and vignetted in printing, the blonde hair, which already photographs much darker, and the light background will make the contrast appear still greater. Hence the expressions: 'No trace of your beautiful light hair;' 'You look like a brunette;' and they are perfectly right. Blondes should be placed on a dark background. If the picture is to be vignetted, then the paper around the head should be colored sufficiently to take away the tone of the paper. The brightness of the head will be preserved, and we get, as everything else is darker, by suitable contrasts, the proper effect of a blonde.

"The same rule holds good for the reverse. We can make a dark, sunburnt gentleman look much lighter by placing him against a dark background; but the likeness suffers, and it is better to use a light background which at once will indicate a dark complexion; but the background should relieve the head on all sides, and not only on one, as we see it on many photographs.

"Imagine the light side of the face of a lady, while the shaded side and the background both have the same color; the two latter of course will melt together and the picture is good for nothing, while, if the background had been moved forward only a few inches, a lighter tint would have been obtained, and the proper contrast secured. In nature the face has by its color, which distinguishes it from the background, sufficient relief, and this is the great advantage which the portrait painter has over the photographer.

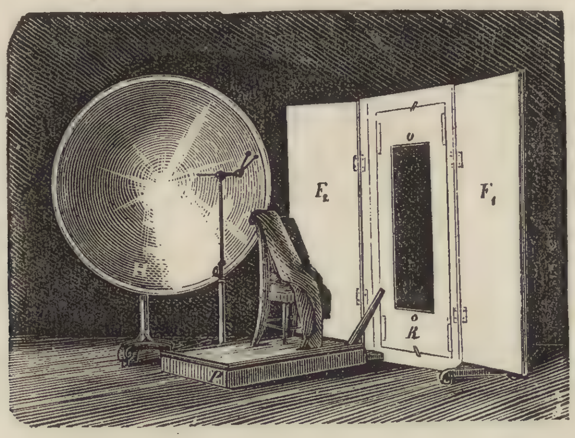
"We photographers have a certain scale of tints, which varies from the purest white (the paper tint) to the darkest black; the painter has these and a great many more, as he can produce these gradations with every color. The relief of the face from the background may appear perfectly good on the ground-glass, while in the negative both will melt together, and cannot be distinguished one from the other when their colors are alike."

Mr. Kurtz employs, besides the flat background, others that are cylindrically curved. It is evident that such backgrounds under suitable illumination will tone off, like a cylinder, a gently graduated surface from dark to light. When we place a person next to a window, the part of the face next to the window will be light, the part opposite to it will be dark. When we place behind the person a cylindrical background, the concave side of which is turned towards the person, then the background will be toned in the reverse order, or darkest nearest to the window, and lightest on the opposite side.

Mr. Kurtz employs of late not only a cylindrical background, but one which is curved like a dish,—a kind of hollow sphere. This is placed in such a manner as to show a gradual toning off, not only from right to left, but in every direction.

The annexed figure shows the background, and at the same time the peculiar reflecting screen of Mr. Kurtz,—a simple wooden frame

FIG. 125.



covered with white paper. The frame has two wings, F_1, F_2, and is placed between the person and the camera. By turning F_1 and F_2 in the proper direction, by moving the screen backward and forward, the illumination of the shadows is accomplished in the most perfect manner. The platform, P, is movable, and admits of turning the person without compelling the same to leave the chair.

The following rules should always be observed: Everything which is put in the picture, such as table covers, curtains, and furniture, must be subordinate, and must not show more prominently than the person, and the lines and outlines of the portrait, the costume, and everything, must form a harmonious whole with the above-named objects.

The less we stand in need of such accessories the better will it be. The painted background will never be more than a make-shift. It is a fault when the background occupies three-quarters of the picture, as we see it frequently. The size of the figure should bear a certain proportion to the whole picture.

It is astonishing how little space is necessary around the figure without the frame appearing too narrow. Take Raphael's Madonna

Sedia, which contains three figures in the narrowest round frame, and still it does not make an unpleasant impression.

The effect of a figure with too large a blank space about it is easily seen in the medallion pictures, which are frequently taken with the carte de visite apparatus at long distances. On the large white paper the head appears much smaller than if we cut it out and look at it separately.

It is also well known that a standing figure appears more slender when the head touches the upper margin of the paper, and to the right and left much open space is left; so also does the figure appear stouter when much upper space and no side margin is left.

Of how much importance accessories are the following communication of Mr. Prümm will explain:

A little lady, only four feet high, complained to this gentleman that in all her pictures she looked so very diminutive. Mr. Prümm knew how to obviate this; he placed the lady next to a toy table in front of a plain background, and took a three-quarter length picture. Alongside the little table the lady appeared very large, and she was highly pleased with the effect. Such contrasts have in many instances extraordinary effect.

The same which we have said before in regard to disorder in the background refers with increased force to the foreground. It is wrong to place a carpet with a striking design or glaring colors in the foreground. Such designs are positively ugly when their figures do not correspond with those of the picture.

A carpet with dull colors and a "quiet" design is the best for full-length pictures. Very often the lustreless, simple floor, or a grass carpet—the latter of course with landscape background—is the best.

Finally, there should be harmony between floor and background in shape and color. A background which is placed an inch above the floor, and separated from the latter by a black line, will always make a "stagy" effect. It is also self-evident that a figure cannot throw its shadow upon a landscape which is considered to be miles away. A certain distance between the person and the background is necessary.

But now to the conclusion,—for the one anxious to learn and to improve, it may come too soon; for the impatient, too late.

I can only give outlines. The realm of art is as infinite as the realm of science, and many a one will exclaim: Too much, too much! how can we practical photographers pay attention to all these trifles? *Arrangement*, *Outlines*, *Drapery*, *Background*, *Ac-*

cessories, *Perspective*, *Position*, *Illumination*, &c., &c.? It is of course too much for the lazy one and for the thoughtless one, but not for the one who strives to excel.

In the world of art the greatest masters have gained the highest success by restless study and indefatigable labor. Look at the studies of Raphael; they are the mute and yet eloquent witnesses of the colossal preparations which this greatest painter of all times made before he attempted such creations as the "Disputa," "The School of Athens," "The Sybilla," and other masterpieces. And it is fortunate that photography is not only a mechanical trade, but a profession in which the intelligent and ambitious artist will always outdistance the merely mechanical worker.

I hope, then, this book of mine may encourage the student to work on, and let him remember the words of Socrates:

"The beautiful is difficult."

APPENDIX.

I. WOODBURY PHOTO-RELIEF PRINTING PROCESS.

When a mixture of chromate of potash and gelatine is exposed under a negative to the action of light, those parts on which the light has fallen will become insoluble in water (see above, Carbon or Pigment printing process), and when the film is afterwards washed with hot water, these parts will remain while the others are washed away. When the exposure has been sufficient, these parts of the picture will appear in relief, and by means of a strong hydraulic press the relief can be transferred to a plate of type-metal. Such a plate would be similar to a copper printing plate. When the depressions are filled with printer's ink a copy can be made on paper. With ordinary printer's ink such a plate would yield but an imperfect print, but when a semi-transparent *gelatine ink* is employed, we will get from the deepest parts of the plate the deepest shadows, and from the smaller cavities the half tones. We are thus enabled to make pictures which in the beauties of the half tones approach the nearest to the photograph. The process is the invention of Mr. Woodbury, and has been carried on practically by Goupil, in Paris, and Carbutt in Philadelphia.

The process is a very important one, particularly when it is desired to produce large quantities of prints from a single plate in a short time. The pictures may also be printed on glass, and yield stereos or magic lantern slides equal to silver positives. Of course differently colored gelatine ink may be employed, similar to the pigment process.

II. ALBERT'S PROCESS (LICHTDRUCK).

A piece of plate glass about five-eighths of an inch in thickness is coated with the following solution:

Water, ...	300 parts.
Albumen, ...	150 "
Gelatine, ...	15 "
Red chromate of potash, . . .	8 "

When the film has become dry, it is exposed for about two hours to light, the glass side uppermost, and backed by a piece of black cloth.

The exposed plate is next coated with the following:

Gelatine,	300	parts.
Red chromate of potash,	100	"
Water,	1800	"

When the plate has become sufficiently dry, it is exposed under a negative; it is next washed, inked with printer's ink, and impressions are taken from it as from a lithographic stone.

The prints show beautiful half-tones.

The printing itself is a very important part of the process, and requires certainly much practical experience, great care, and many precautionary measures in order to secure success.

III. PHOTOGRAPHIC OPTICS.

ON THE ABSORPTION OF LIGHT IN WET OR DRY PLATES.

OMMEGANCK has made some interesting experiments. Two sensitized wet plates were placed one behind the other and exposed in the same plate-holder. When the collodion was strongly iodized, the second plate showed only traces of a picture (caused by the rays of light passing through the first plate); when the collodion was feebly iodized, the picture on the second plate was almost as powerful as on the first. By employing a dry plate, the picture on the wet back plate became even more powerful. Ommeganck sees in this transmission of light the cause of the inferior sensibility of dry plates, proposes to employ opaque glass, and to use only the negative film which has been previously detached from the glass.

IV. PRACTICE OF PHOTOGRAPHY.

ON THE REPRODUCTION OF DRAWINGS WITHOUT THE CAMERA.

Mr. L. E. Walker, the superintendent of photographic work for the Treasury Department in Washington, which work consists principally in reproduction of architectural plans and drawings, employs a process of reproducing drawings by a kind of natural self-print. He does not claim to be the inventor, but it is certainly to the credit of Mr. Walker that he has modified and perfected the process very much. He describes it as follows:

1. The drawing which is to be copied should be made on very

thin paper, or better still on tracing linen. A very dark black or other color should be used for the drawing, strong enough to prevent the light from passing through. The lines should be made very sharp, and with one stroke, that they may not show breaks.

2. *The making of the negative.*—A smooth, dull paper should be used; it should be well salted, silvered, and fumed for from ten to fifteen minutes with ammonia. The drawing is now placed in the copying-frame, the drawing uppermost; the sensitized paper is placed on top of this; the frame is closed and exposed to light. With bright sunlight an exposure from one and a half to two minutes will be sufficient for a picture. The exposure should not be made too long, as this will cause the feeble lines to run together and give it a feathery appearance. The superfluous silver is washed away, the print is toned slightly, and fixed like any other print. The picture should be well washed and hung up to dry, preventing its curling as much as possible. The negative is now ready, quick, and cheap, and any number of positives can be taken from it, which will be in every respect like the original.

3. *Making the positive.*—The negative, back downward, is laid on the plate-glass of the copying-frame; the sensitive paper is laid on top of it and exposed.

4. *Salting the paper.*—A bath should be made of 2.5 grammes sal ammoniac, and 3 grammes gelatine to 480 grammes of (hot) water; the sheets are dipped in this solution for 2 or 3 minutes and dried in a warm room.

5. *Sensitizing the paper.*—The paper is brushed with a slightly acid solution of the oxide of nitrate of silver and ammonia, 1 : 16; it is well dried and fumed for 15 minutes with ammonia. (The solution of oxide of nitrate of silver and ammonia is made in the following manner: To a solution of nitrate of silver, 1 : 10, ammonia is added drop by drop until the first formed precipitate has redissolved. Nitric acid is added drop by drop until a slight acid reaction takes place.)

6. *Toning, fixing, and washing.*—To 1750 grammes of water 1 gramme chloride of gold and 1 gramme chloride of platinum is added; the liquid is neutralized with carbonate of baryta; it is well shaken and placed in a warm place for 4 or 5 days, when it is ready for use. This is the stock solution. Two or three hours before use 1 gramme of neutral solution of chloride of gold, 1 : 16, should be added for every sheet of albumen paper to be toned, or about ½ of a gramme for ordinary paper. In toning everybody may follow his individual taste.

Mr. Walker considers this bath very economical, as it can be used for months.

I have described the process very particularly, as it is very useful. Before the albumen paper was introduced a paper print was used in place of the negative when the latter had been lost. Now we make a virtue of necessity, but in another direction.

THE REDUCTION OF SILVER RESIDUES.

Of the large quantity of silver which photographers use, particularly in the positive process, we find, according to Davanne, about,

a. 3 per cent. in the finished picture.
b. 7 per cent. in the drippings, filters, paper trimmings, and in the paper with which wasted solution has been wiped up.
c. 50 to 55 per cent. in the wash water of the exposed paper in the form of a silver salt.
d. 30 to 35 per cent. have been passed into the fixing bath.
e. 5 per cent. at most in the wash water of the fixed prints.

To recover these residues is financially a matter of great importance.

Usually photographers collect the first wash water in a barrel, and precipitate the silver with common salt. An excess should be avoided, as it will retard the precipitation of chloride of silver.

After twenty-four hours the clear water is drawn off the precipitate, and silver water is collected again; when this process has been repeated for months, the precipitate of chloride of silver is collected on a cloth, washed with water, and dried.

The silver which has been recovered from the *developing solution* (negative process) may be added to the above.

To reduce the dry mass the melting process is the most suitable.

A good Hessian crucible is heated in a furnace to a red heat, and *gradually* the following *perfectly dry* mixture is introduced:

Chloride of silver residue, ...	3 parts.
Carbonate of soda, FREE FROM WATER,	1–1½ "

It is well to rub the inside of the crucible, with chalk or white clay, previous to heating it.

The smelting should be continued until the whole mass, which at first froths very much, flows even; it is then allowed to cool, the crucible is broken, and the button of silver is taken out.

Liesegang recommends precipitating the silver with oxalate of

soda or potash, as oxalate of silver, which is easier reduced than chloride of silver.

Fixing waters of hyposulphite of soda are collected separately in large earthen jars, large enough to hold the water of two days, or the fixing bath and the first water after fixing of from 4 to 6 days. In each jar a bright copper plate is placed, or better still two plates opposite to each other. The metallic silver will collect on these plates in 48 hours, and can be removed with a stiff brush. The precipitate which has been brushed from the plates may be taken out at once, or it may remain until a sufficient quantity has collected for smelting purposes; at all events after brushing off the precipitate sufficient time should be allowed for it to settle.

When it is removed from the liquid, it should be filtered either through linen or paper, according to quantity, and be dried in the open air or on a stove.

After this mix

100	parts of	the washed and dried silver powder,
50	"	melted and powdered borax,
25	"	" " " saltpetre.

The saltpetre has to oxidize the particles of copper which have been removed by the brush. The crucible is filled one-third full with the mixture, and when the foaming has ceased it is heated for about twenty minutes longer on a brisk fire; the mixture is then allowed to cool, and the crucible is broken.

The resulting metal contains some copper, but this does not do any harm; it can be used for producing the silver salt by dissolving it in nitric acid.

Papers containing silver should be collected and burned; the ashes are collected, and when all organic matter has been removed by heat, a mixture should be made of

100	parts of	ashes,
50	"	dry carbonate of soda,
25	"	quartz sand.

The melting goes on rapidly, and the result is a quantity of silver varying from 20 to 60 per cent., according to the composition of the papers.

ON TECHNICAL ERRORS.

The number of errors in the photographic process is legion. The cause is partly owing to changes in our apparatus and solutions, and the errors resulting from this cause have been treated of in the

chapters on the Care of the Solutions. Those who have studied these chapters carefully, and know how to apply what they have learned, will know at once how they can meet a great many of the blunders. On the other hand, carelessness or want of skill of the operator causes a great many more.

Any one who does not always exercise the most conscientious care in all his operations will always have to contend with mistakes. Certain faults, such as careless illumination, wrong time of exposure, or wrong pose, will occur to every beginner. Experience only can overcome them.

ERRORS IN THE NEGATIVE PROCESS.

These show themselves generally in *developing.* And I would recommend never to *intensify* and *finish* a plate until it has been ascertained that *after development*, *washing*, and *cleaning of the back*, the plate is free from faults.

The principal fault is fogging; it is a general precipitate over the whole plate, also over those parts which have not been exposed to the light at all. The causes are manifold: *a*, the so-called dark-room admits white light (the author works only by lamplight); *b*, the plate has been exposed to strong lamplight for some time; *c*, the camera or plate-holder is not light-tight (in the latter case we will have spots opposite the holes admitting light); *d*, bright light enters the tube (this happens frequently when the camera is placed opposite to an opening in the curtain or the bright sky); *e*, the collodion is alkaline (in this case a few drops of tincture of iodine will remedy it); *f*, the nitrate bath is alkaline (the remedy is an addition of acid); *g*, the bath contains organic substances, and in consequence the plate is deficient in sensitiveness (the remedy is permanganate of potash); *h*, the bath contains nitrous oxide of silver.

The other faults arrange themselves according to their origin.

ORIGINAL ERRORS.

Some small yellowish spots, which the eye is scarcely able to discover, as freckles in the original, and iron spots on paper, become very prominent in the photograph, and are often laid at the door of the chemicals.

FAULTS IN CLEANING AND POLISHING.

1. Precipitates of a silver-like appearance between the collodion film and the glass (best visible from the back of the plate) are caused by badly cleaned, old, and carelessly treated plates.

Remedy.—Place them in a strong solution of chromate of potash. If this does not do, such plates can still be used by albumenizing them.

2. Moss-like excrescences on the plate. Dirty plate-holders.

3. Dirty margins or spots proceeding from the corners and extending more or less to the centre are caused by insufficient cleaning of the rough edges, or by their subsequent soiling by placing the plates on dirty tables, papers, plate-holders, &c., or by taking hold of them with dirty fingers.

4. Streaks caused by imperfect cleaning manifest themselves plainly by showing the direction of the motion employed in cleaning the plate. Cracks in the glass frequently cause streaks when the cleaning powder collects in them.

5. Bright and irregular points and short lines are caused by dust and woody fibres, which drop on the plate in opening the plate-holder.

FAULTS IN THE COLLODION.

1. The plate leaves the bath with a transparent insensitive margin. The cause is, that the plate was too dry when dipped in the bath.

2. The film is rotten, and is apt to tear in the bath. The film had not sufficiently set when dipped in the bath, or the collodion was too old.

3. The film is of an uneven thickness. Caused by unequal coating.

4. Spots proceeding from the corner by which the plate has been held (see page 107).

5. Thick and thin streaky places. The consequence of air-bubbles which have burst just previous to the "setting" of the collodion; also a consequence of unequal drying influenced by the warmth of the fingers or by the evaporation of collodion on the back of the plate; also caused by old pyroxyline, which dissolves imperfectly.

6. Diagonal streaks (see page 106).

7. Comets. Cause: freshly iodized and imperfectly settled collodion. Black and white serpent-like lines also occur with new and imperfectly settled collodion, particularly with potassium salts, that do not dissolve readily; they disappear after filtration or perfect settlement.

8. Intense cold is apt to form cross-like shadings.

9. Black and irregular spots. Dirt from the neck of the collodion bottle.

10. Collodion, which works well in the beginning will after a short time yield imperfect plates. Cause: the collodion has become impure by pouring it back from the plate into the bottle.

11. Want of sensitiveness is often met with in old and red collodion.

12. The collodion film does not stay on the plate. Cause: An old and acid bath; imperfectly cleaned plates; old pyroxyline.

13. Fogginess, the causes of which have been fully explained.

FAULTS OF THE NITRATE BATH.

1. White *dipping lines*, caused by stopping the plate when partly immersed, partially straight and horizontal, when an upright bath is used, and partly curved when dishes are used, or round spots caused by air-bubbles.

2. Black lines in the direction of the dip, particularly with an upright bath, but also with dishes, the film being downward. Cause: The time for silvering was too short, or an old bath surcharged with organic substances.

3. Black lines proceeding from the dipper. Cause: India-rubber dipper.

4. Plates in which the film is partially destroyed. Cause: The bath contains too little or no iodide of silver.

5. Transparent and pale-looking insensitive plates occur sometimes in extremely hot weather. The remedy is to cool the silver bath.

6. Spears, crosses, and swords. Cause: Sulphate of silver or acetate of silver.

7. The plates appear as if they were dusted over with flour. Cause: Considerable reduction and precipitate of iodide of silver, caused by extreme heat. The remedy is filtration and cooling.

8. Pinholes. Remedy: Cooling and restoring the bath.

9. Black spots caused by pressure on the collodion film; originate frequently from protuberances on the sides of the bath or dish.

10. Want of sensitiveness is caused by an excess of acid, and also by the presence of organic substances.

11. Gray and grizzly spots are caused by imperfect scumming.

12. Fogginess. See above.

13. Weak pictures are caused by an old and frequently restored silver baths.

ERRORS OF EXPOSURE.

1. Want of sharpness, or double outlines. Cause: Careless focussing, moving of the object, or shaking of the apparatus during exposure.

2. Marbled stains and drying spots, caused by long exposure or great heat (see page 225).

3. A hard picture: the illumination was too short; a weak picture is sometimes produced by an excess of illumination.

4. The picture shows unequal intensity (unequal illumination, particularly in drawings) (see page 221).

5. Foggy spots are caused by reflections of light, on drawings.

6. Veiling is produced by extraneous light, see above.

ERRORS OF DEVELOPMENT.

1. A bright margin on the side where the developer has been poured (see page 113).

2. Crooked lines, developing streaks (see page 113).

3. The film repels the developer: in this case the developer contains too much alcohol, as with a new-made bath; or too little, as with an old bath.

4. A dark margin to a light object, on the side where the developer has been poured on (appearing in the positive as a bright halo), is a very common error of development.

5. Veiling is often occasioned by a too strong, too warm, or a developer deficient in acid.

6. Most of the above errors only show themselves on development, although strictly speaking they are not errors of development.

ERRORS OF INTENSIFYING.

1. The intensifier is repelled and produces spots, particularly when we intensify with the salts of iron (see page 115).

2. Pale spots will be produced when the intensifier. no matter which one, does not flow evenly over the whole plate.

3. A gray and grainy precipitate is formed when the iron intensifier is left to act until it becomes turbid.

4. A bluish precipitate is formed in the shadows when there is a deficiency of acid, or by employing an old pyrogallic solution.

5. Thick spots will form when the intensifier is always poured on the same place, particularly in long-continued intensification.

ERRORS IN FIXING.

1. The plate is greenish or bluish. The cause of this is, that the plate has been fixed with cyanide of potassium, is imperfectly washed, and after-intensified with a solution containing iron. Thorough washing after fixing will avoid it.

2. Black streaks, mainly visible from above. Cause: too cold or too diluted a fixing solution, or insufficient flowing of the same.

3. Thin places are formed when too strong a solution of cyanide of potassium has been used (see page 116).

FAULTS THAT APPEAR IN DRYING.

The film shows the colors of the rainbow and peels off. This takes place with plates which have had a short exposure and strong intensification. Such plates can be saved when they are varnished, when still damp; they are then left to dry and revarnished.

FAULTS IN VARNISHING.

1. Dissolving of the film; 2, weak film; 3, streaky film (see page 117).

For faults in the finished negative, see the article, the Care of the Negative.

ERRORS IN THE POSITIVE PROCESS.

1. Air-bubbles (see page 144).
2. The paper repels the bath. The albumen film is too dry.
3. The silver solution collects in the centre of the sheet in drops: this is partially avoided in the same way as fault 2; the drops can also be removed by blotting-paper.
4. The paper is too dry or too wet; it copies weak or uneven (see page 145), or spoils the negative (see page 144).
5. The bath turns brown (see page 157).
6. Grayish dirt; from imperfect scumming of the bath.

ERRORS IN PRINTING.

1. The picture looks weak, the shadows are dull, the high lights look cloudy. Cause: the bath was too acid, too old, or too diluted; the paper has been dried too much or too little; the negative was too thin,—in the latter case the printing should be carried on under green glass, or the negative should be varnished with a varnish

containing dragon's blood (1 part dragon's blood to 200 parts of varnish).

2. When the high lights are weak, the cause is often that the prints have been too often examined in diffused light.

3. Turning yellow from long-continued printing.

4. Brown lines. Cause: remnants of fibrin in the albumen.

5. The print is in some parts not sharp. Cause: the paper is not pressed with uniform firmness against the negative, the paper is wavy; this takes place when the temperature of the sensitizing room is very different from the temperature of the printing room. The remedy is to place the paper for half an hour in the printing-room before placing it into the printing-frame.

ERRORS IN WASHING.

1. Black precipitates are formed by substances in the water containing sulphur, or by remnants of hyposulphite of soda in the dishes, particularly in India-rubber dishes.

2. Brownish-black spots are formed by taking hold of the prints with fingers soiled with solutions of soda.

ERRORS IN TONING.

1. The picture does not tone even. Cause: want of gold solution; the prints are not moved sufficiently in the solution; the prints stick together, preventing the toning solution from penetrating; the prints have been kept too long after being printed.

2. The picture does not tone at all:

a. Iodide of silver, or much acid, or foreign metals are present in the positive bath (see page 129, on printing bath made from negative bath). Such a bath (after the iodide of silver has been removed by four or five-fold dilution) is evaporated to dryness, and melted moderately for some time. The acid escapes; the salts of the metals are to a large extent dissipated.

b. The washing water is contaminated with substances containing sulphur.

c. Want of gold.

3. The high lights become colored. Cause: too much diffused light in the toning room.

ERRORS IN FIXING.

1. Lines are formed in consequence of careless immersion of the

print into the fixing bath, or spots are formed by letting drops of the bath solution fall on the prints previous to immersion.

2. Yellowish spots on the prints, which sometimes become visible only when the prints are finished. Cause: air-bubbles on the paper. Remedy: moving briskly every sheet of paper after immersion in the bath.

3. The fixing bath is too old (see page 163).

4. Cloudy spots are caused when the fixing has been too short.

ERRORS IN WASHING AFTER FIXING.

1. The pictures become spotted (see page 156).

2. They stick together or to the sides of the vessel, and turn yellow easily in consequence of the remnant of soda remaining in the paper (see page 149).

3. The washing has been insufficient (see page 150, soda test).

ERRORS IN FINISHING.

1. Danger from drying between blotting-paper (see page 151).
2. Faults in the mounts (see page 151).
3. Faults in the paste (see page 151).
4. Faults in pressing (see page 152).

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L.

M.

CORRECTIONS.

Page 29, fifth line from below, read, "at the same ratio as the squares of the distances," instead of, "at the same ratio as the distances."

" 62, eighth line from below, read, "plane," instead of, "plain."

" 71, twelfth line from above, read, "smaller," instead of, "larger."

" 89, sixth line from above, read, "bromide of sodium," instead of, "iodide of sodium."

" 107, second line from below, read, "coated with collodion," instead of, "silvered."

" 141, fourth and fifth lines from below, read, "grammes," instead of "grains."

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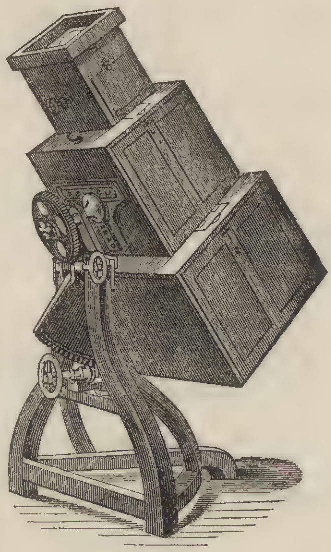

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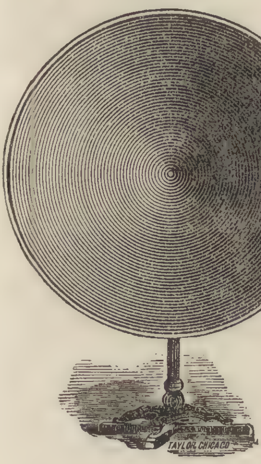

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Being a complete course of instructions for Varnishing and Retouching Negatives (Contact or Solar), also positive Pictures. To avoid all difficulties that may occur in the Chemical and Optical operations in taking Portraits, it is necessary for every Artist having a desire to perfect himself in his profession, and entirely satisfy the different tastes of his customers, to make himself thoroughly acquainted with the retouching process. This book describes in a short and practical manner the whole retouching process. By following closely the instructions laid down in this *Book*, Photographers will be enabled to make rapid improvements in their profession. Full directions for doing solar negative work will be found in the same. Also, for using my new *Ground Surface Negative Retouching Varnish*. Patented December 6, 1870.

The Book is illustrated with samples of Photographs retouched and unretouched, showing in a fine manner the difference between the two, and the advantages of the retouching process.

Will be sent post-paid to any address on receipt of $1.50.

Those wishing to procure a Sample Negative can have the same sent post-paid for $1.50, by addressing

JOHN WOLFGANG MORGENEIER, Photographer,
Sheboygan, Wisconsin.

Stockdealers supplied with Books by Wholesale on Reasonable Terms.

I wish also to call the attention of brother artists throughout the country to my

NEW PATENT VARNISH.

It enables a photographer having no knowledge of drawing to retouch any negative, using only Faber's Polygrade Lead Pencils, from No. 1 to No. 5, or water colors and dry colors; negatives being taken on plain glass.

This varnish is applied in the same manner as any other. A negative coated with it is greatly improved without retouching, yet there is no process known, nor will there ever be one discovered, by which the negative will be sufficiently improved without the use of the pencil. My process is the first discovered to varnish and retouch solar negatives, it being considered, before this time, an impossibility to varnish and retouch the same.

The Advantages of this Varnish are—

1. That all other processes and materials used before are wholly unnecessary.
2. It saves time, labor, and expense.
3. There is no other application necessary.
4. There is no danger of injuring the negatives.
5. It makes a much softer and more lustrous print.
6. It works in the same manner in all degrees of temperature.
7. The pencil works upon the film of such a negative as upon white paper.
8. Every photographer will be enabled to use a Solar Camera, which, until the present time, has been confined to artists who were well acquainted with the positive retouching process.

☞ The Varnish is manufactured under my personal supervision, and is guaranteed to work as represented. WILL BE SOLD WHOLESALE AND RETAIL BY DEALERS.

8 ounce bottles, 75 cents. 16 ounce bottles, $1.40.

All orders and communications will receive prompt attention. *Price list sent on application.*

J. W. MORGENEIER, Photographer,
Box 17, Sheboygan, Wis.

SCOVILL MANUFACTURING CO., General Trade Agents.
4 Beekman Street, New York.

GEM, CARD, AND UNIVERSAL CAMERA BOXES.

No. 8.—Gem Box for 12 Pictures on a 1–4 Plate using 12 Tubes, 1–9 to 1–2 sizes Reversible, using 1 Tube, and 2 Cards on a 1–2 Plate using 2 Tubes	$25 00
No. 9.—The same Box fitted with 12 Tubes	60 00
No. 10.—The same Box fitted with 4 additional Tubes for making 4 Pictures on a 1–4 Plate	75 00
No. 11.—For 4, 8, 12, and 16, on 1–4 Plate 1–9 to 1–2 Reversible, and 2 Cards on a 1–2 Plate	35 00
No. 12.—The above fitted with 4 Darlot Tubes	50 00
No. 13.—Card Camera Box for 2 Cards on a 1–2 Plate, using one Tube, and 1–9 to 1–2 Pictures, Reversible	25 00
No. 14.—4–4 Card Camera Box, Covered Front, for 4 Cards, using 4 Tubes with side-doors for adjusting the focus	45 00
No. 15.—9 x 11 Card Camera Box, Covered Front, for 8 Cards using 4 Tubes, with side-doors for adjusting the focus, Sideway Movement	55 00
No. 16.—4–4 Card Camera Box for 4 Cards using 2 Tubes, Upright Movement	30 00
No. 17.—4–4 Universal Camera Box for 4 Cards using 2 Tubes and 1–6 to 4–4 Pictures, Reversible using 1 Tube, Sideway Movement	35 00
No. 18.—4–4 Universal Camera Box for 4 Cards using 2 Tubes and 1–6 to 4–4 Pictures, Reversible using 1 Tube, Sideway Carriage Movement	40 00
No. 19.—8–10 Universal Camera Box for 4 Cards on 4–4 Plate using 2 Tubes and 1–6 to 8–10 Pictures, Reversible using 1 Tube, Upright Movement	45 00
No. 20.—8–10 Universal Camera Box for 4 Cards on 4–4 Plate using 2 Tubes and 1–6 to 8–10 Pictures, Reversible using 1 Tube, Sideway Movement	45 00

Card Camera Boxes, fitted with the Double Card Attachment, for making two different pictures in different positions of the same subject on the same card, $5 extra.

No. 2 CAMERA BOXES.

(Compo. Corner Holders.)

To meet the wants of a large class of customers who give preference to Camera Boxes of their manufacture over those of all others, they have been induced to put into the market a cheaper class of Boxes, not so highly finished as their No. 1 goods, and without the Patent Brass Guides, but, at the same time, *good, well-made, true,* and *reliable* Boxes, and, without doubt, the best of their class in market. We can recommend them as being of superior workmanship when compared with others of same price.

No. 40.—1–4 size, Reversible for Plate 3¼ x 4¼ inches	$9 00
" 41.—1–2 " " " 4¼ x 5½ "	10 00
" 42.—4–4 " " " 6½ x 8½ "	15 00
" 43.—Ex. 4–4 " " 8 x 10 "	22 00
" 44.—Ex. 4–4 " " 8 x 10 " with Focus Rack	24 00
" 45.—10–12, Reversible, with Focus Rack	35 00
" 46.—11–14 " " "	40 00
" 47.—14–17 " " "	52 00
" 48.—17–20 " " "	70 00
" 49.—4¼ x 6½, for 2 Cards, with 2 Tubes	10 00
" 50.—4–4 Reversible, with attachment for 2 Cards on 4¼ x 6½ Plates with 2 Tubes	18 00
" 130.—4 x 7—4 x 8 or 5 x 8, Stereo. Cam. Box	20 00

THE VIEW CAMERA BOXES

Manufactured by the American Optical Company are:

(Patent Glass Cor. Holders.)

					Single Swing.	Double Swing.
No. 21.—	For View	4¼ x 5½	inches,	Reversible,...$25 00	$30 00	$35 00
" 22.—	"	6½ x 8½	"	" 35 00	40 00	45 00
" 23.—	"	8 x 10	"	" 40 00	45 00	50 00
" 24.—	"	10 x 12	"	" 50 00	55 00	60 00
" 25.—	"	11 x 14	"	" 60 00	68 00	75 00
" 26.—	"	14 x 17	"	". 70 00	78 00	85 00
" 27.—	"	17 x 20	"	" 85 00	93 00	100 00
" 28.—	"	20 x 24	"	" 100 00	110 00	115 00

WITH VERTICAL SLIDING FRONT FOR ADJUSTING FOREGROUND AND SKY.

These Boxes are the only ones made in this country which combine Portability and Lightness with Durability and Perfect Accuracy — qualities which every Operator will appreciate.

THEY MAKE THE FOLLOWING STYLES

OF

GEM BOXES.

(Composition Corner Holders.)

New York Gem, complete with four 1-9 Darlot Tubes; will make 4, 8, and 16 on a 1-4 Plate, 2 cards on a 1-2 Plate, 1-9 to 1-2 Reversible.. $35 00

No. 40 G. — 1-4 Gem Boxes with four Darlot Tubes complete; will make 4 Pictures on 1-4 Plate and 1-9 to 1-4 Reversible.................. 25 00

No. 41 G. — 1-2 size Gem Box with 6 Darlot Tubes; will make 6 Pictures on 1-2 Plate and 1-9 to 1-2 Reversible............................ 35 00

No. 42 G. — 4-4 size Gem Box with 12 Darlot Tubes; will make 12 Pictures on a 4-4 Plate and 1-6 to 6½ x 8½ Reversible................ 65 00

No. 42 F. — 4-4 size Gem Box with four 1-4 Tubes will make 4 Pictures on 6½ x 8½ Plate and Regular work 1-6 to 4-4......................... 45 00

THE STEREOSCOPIC BOXES,

Patent Glass Corner Holders.

Manufactured by the American Optical Company are :

		Single Swing.
No. 29.—For Plate 4 x 7 or 4 x 8 inches	$25 00	$30 00
" 30.—The same Box arranged with an extra front for 1-4 or 1-3 Lenses, with folding platform	30 00	35 00
" 31.—For one Lens for Plates 4 x 7 or 4 x 8 inches	25 00	30 00
" 32.— " 1-4 or 1-3 Lens for Plates 4 x 7 or 4 x 8 inches	30 00	35 00

THE NEW PHILADELPHIA BOX,

Patent Glass Corner Holders,

For Stereo and Single views, Reversible for Plates 5x8 inches	30 00	35 00

For full description, see April number, 1870, *Philadelphia Photographer*, page 100.

SCOVILL'S NEW IMPERIAL AND CARD CAMERA BOX.

Patent Glass Corner Holders.

4½ x 6½, KIT INCLUSIVE, AND 2 CARDS.

With Double Swing Back and Carriage Movement, making 8x10 to 1-6 Pictures and 2 Imperial Cards on an 8 x 10 Plate using 1 Tube	$55 00
Without the Double Swing Back	45 00

Silver Saving Bottle in Holder, $1.00 extra.

The same as above, except 6½ x 8½ instead of 8 x 10, Double Swing Back	50 00
Without the Double Swing Back	40 00

Silver Saving Bottle in Holder, $1.00 extra.

THE CHICAGO CARD BOX.

No. 13.—For 2 Cards on a 1-2 of 4-4 Plate and 1-9 to 1-2 Picture, Reversible	$25 00
With Double Swing Back	35 00

VICTORIA BOX.

Solid Glass Corner Holders.

Making 5 x 7 to $\frac{1}{8}$ inclusive.
2 Victoria Cards on a 5 x 7 Plate.
4 " " " " "
8 " Gems " " "

PRICE.

With $4\frac{1}{4}$ Darlot Tubes $75
Without Tubes.................................... 35

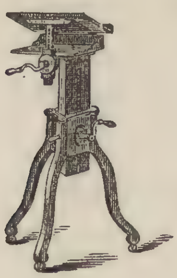
REGULATION

OF THE

8 x 10 AMERICAN OPTICAL COMPANY'S MULTIPLYING BOX.

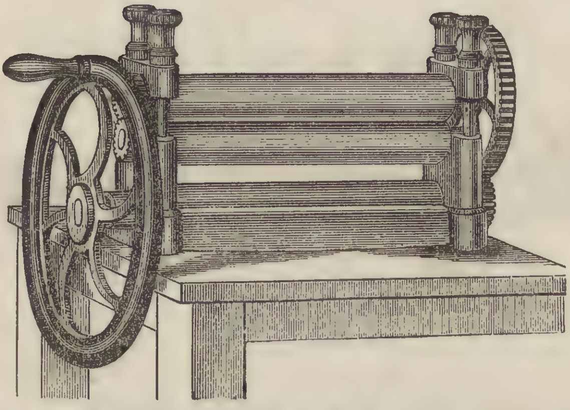
72 Gems on 7 x 10 Plate.
36 " " "
18 " " "
9 " " "
36 " 5 x 7 Kit in the centre.
8 Cards on 7 x 10 Plate, with two 1-4 or 1-3 Lenses.
8 Cards, with 1 Lens for Copying.
4 small Imperials on 7 x 10 Plate, with 4-4 Lens.
2 large 4-4s, with 4-4 Lens.
Regular Work, from 1-4 to 8 x 10, inclusive.

It can also be arranged so as to take 8 Cards with 1-4 or 1-3 Lenses, which requires another Diaphragm.



THE PERFECT CAMERA STAND.

This Stand has been pronounced by all who have used or examined it, as "the *best* ever made." The *Philadelphia Photographer* justly says, "It is a *Perfect* Camera Stand." It is strong, quickly raised, lowered, and adjusted, is handsome, and will last a careful man a life-time. Price, $25.



SCOVILL'S ROLLER PRESSES.

The wide reputation these Presses have won in the face of severe competition is due to their merits alone, as they combine all the good qualities which constitute a superior Press. The advantages they possess over **all** other presses in the market are, **Cheapness, Simplicity**, convenience, with **Durability, Ease** and **Rapidity** of working, together with **Evenness of Pressure.** They are cheaper than any other Press that will finish pictures as well.

They are the most **Simple in Construction** of any Press in market, **well** and **strongly made** of the **best materials**, and therefore are **more durable** than any other.

More pictures can be pressed within a specified time, with a finer surface and with less expenditure of strength on the part of the operator than with any Bed Plate Press, as the Rollers can be turned with one hand easily, and fed with the other as fast as the cards can be picked up.

They will finish pictures more evenly than any ordinary Bed Plate Press, having been tried in comparison with every style in market, as we wished to determine which was the best Press manufactured before introducing them, and have satisfied ourselves that the only Bed Plate Press which will finish pictures as well as the EXCELSIOR, is one which costs Three Hundred Dollars. We have also satisfied ourselves, together with many others, that the manner in which a Card is pressed has nothing to do with its curling, as they curl equally alike whether pressed between two rollers or in a Bed Plate Press.

We have completed our arrangements so that we are enabled hereafter to offer them at the following reduced prices. We shall continue, as heretofore, to keep up the quality, making them not only the **Cheapest** but the **Best** Press in the market, and justly deserving the name of

"EXCELSIOR PRESS."

5 inch Rollers,	*$10.50.*	*8 inch Rollers,*	*$16.50.*
6 " "	*11.50.*	*10 " "*	*18.00.*

12 inch, Extra Gearing, $27.50.